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Journal of the Society of Motion Picture and Television Engineers

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# Cutting Feature Films for Television

By JOHN LEE WIEGAND

Editorial Note: *The author of this paper has undertaken an exhaustive study of the use of feature films on television with emphasis on editing methods. His paper was divided into six chapters: I, A History of Feature Films on Television; II, Distributors and Prices; III, The Editor and His Assignment; IV, Editing a Feature; V, Examining a Cut Feature Film; VI, Conclusion. The following condensation is based mainly on excerpts from Chapters III and IV. Admittedly in the condensing of any serious and extensive work, there is the risk of perpetrating the "unabashed mayhem" which is the author's description of the consequence of editing a feature to about half its original running length. In making this condensation (with the approval of the author) every effort was made to avoid "mayhem."*

## Introduction

Between 1950 and 1959 the most significant change in television programing was the transition from "live" television to filmed or taped presentations. How do these films fare in the station's hands? If they are cut, exactly how is it done? This study is an attempt to answer these and other questions which bear on the role of feature films in television.

The term, feature film, is used to designate a motion picture which was originally made for distribution in motion-picture theaters. Its running time varies widely but usually will not be less than 60 minutes and may run over 140.

## Editing Films for Television

(Editing methods of seven television stations in the New York area were examined in making this study, but it may be assumed that the methods described are representative of editing methods used in television stations throughout the United States.)

The organization of the film departments of the seven TV stations in the New York area varies slightly. In most cases there is a film manager who buys film for the station and is also ultimately responsible for the operation of the film department.

For the most part, the film editors at New York's local TV stations have come from television trade schools or have learned on the job. About one-fifth have had some kind of production experience. The figures are:

| *No. of Editors* | *Experience* | | |
|---|---|---|---|
| | *Production* | *Trade School* | *On the Job* |
| 47 | 10 | 19 | 18 |

As a rule those editors longest with the TV station are the ones with production experience. Production experience is defined here as experience in processing laboratories, 16mm documentary work or even theatrical projection work, in addition to original editing of films. When stations were first shopping around for men with film experience, they had perforce to draw on the existing skills; but since the late forties and early fifties TV stations have largely trained their own film workers, providing them with new criteria of quality more suitable to the medium.

There are a variety of ways of devising a program slot for a feature. The four most common program times are one hour, one and one-half hours, two hours, and the full running time of the feature.

A film may run its full length, as a first-run feature, in a late evening slot then, several months later, be cut to fill an hour and a half program in the early evening and then still later, as a re-re-run, be cut to an hour-long program in the morning. Once a feature has been cut to fit a certain time slot it can be left in that condition until it is scheduled to play again. If more commercials are added the film must then be further edited. If there are fewer commercials than originally scheduled, public service announcements can be used to fill out the time.

Once a picture has been assigned to a certain show, the editor screens it, edits it to the required time, determines where the commercial breaks will occur and, sometimes, inserts the commercials in the show itself. He may also determine how long the feature should run, taking into consideration the number of commercials and other elements in the format of the show, and he must be able to judge the quality of the prints in relation to their suitability for telecasting.

## Butchered Films

No one is more aware than the television editor of the "butcheries" of the feature films of a decade or so ago which often occurred because of a shortage of personnel, or inexperience, and its corollary, low pay. Understaffed film departments were responsible for preparing all filmed commercials and syndicated half-hour shows, as well as the re-editing of features. There simply was not the time to do anything more subtle than "cut from the head."

The passage of time has brought a greater proficiency. Morale is surprisingly high among the editors at stations surveyed by the author. While the editors are aware that if a feature is of necessity reduced to half its original running time it is unabashed mayhem, still, for a normal cut, they take pride in the job they do and the special skill they have developed to

A contribution submitted on March 25, 1960, by John Lee Wiegand, 308 W. 93 St., New York 25. This tutorial paper is an extract from a thesis submitted for the degree of Master of Fine Arts at Columbia University. The author is now on the announcing staff of WNYC, the New York City municipal station.

**Fig. 1. Artificial fade-out on soundtrack.**

make the deletions as unobtrusive as possible. The past decade has witnessed a great improvement in the quality of TV editing, but certain inadequacies remain. A common plea is for more time, and this the editor is seldom granted. One film manager bemoaned the "conscience" of his editors because it tended to slow down their work. In the seven stations surveyed, two hours is the time usually alloted to cut ten minutes out of a feature. The most liberal figure is forty hours to cut a 35mm feature. Two to two and a half hours is hardly long enough to prepare an hour and a half's entertainment, even if it is on film.

But there seems to be no real pressure on station managers to improve the re-editing of feature films. Newspaper critics seldom comment on the editing quality and complaints from the public to the stations range from none to four per week. The film managers interviewed felt that the quality of the editing was not noticed by the general audience unless it was extremely bad. And, of course, very few individuals take the trouble to express dissatisfaction where it might do some good.

The television editor is hired to cut any and all features to which he is assigned, regardless of the length of the cut entailed. The worst cutting jobs, where the picture is disembowelled, occur mostly on extremely long features which are reduced to around seventy-five minutes. Were there a greater flexibility in the programing, allowing for a two-hour play-off time when needed, the optimum limits of editing would not be violated. No one is more aware of the point beyond which the story will lose coherency than the editor. The long features have been bought and must be played; there is no question of that. To schedule them in a time slot where mutilation is obligatory is to reduce them to the nature of program "fill." The general lack of respect for the quality presentation of feature films on television is characteristic of too many stations at the managerial level. This is reflected in the speed at which the editing is expected to be done and the careless scheduling of pictures.

## Editing Techniques

The feature arrives at the station in the form of a composite release print. Since the position of the soundhead is traditionally lower than the aperture in projectors, and the film is threaded from the top to the bottom, this accounts for the printing of the soundtrack ahead of the picture. The distance between the aperture for the picture and the slit of light focused on the soundtrack represents the sound advance. The problem posed by the track advance is the major challenge in TV feature editing.

The most important equipment used in the re-editing of a feature film, besides such basic tools as rewinds, splicer, synchronizer or footage counter, and flange, consists of a viewer and and a sound reader. The viewer is a device enabling the editor to look at the picture portion of the film, usually reflected onto a ground glass surface. Since the film is drawn through it manually it is possible to watch a film frame by frame or to rush it briskly through the viewer. The sound reader audibly reproduces the modulation on the track. By listening to the naturalness of the track while winding the film at sound speed, the editor can judge the length of a shot before cutting it.

The length of a shot becomes particularly significant if there is no sound with it. If the track is unmodulated the editor can wind the film back to a modulated portion, attain the correct speed, and hold it over the silent section. This is a faster technique, but less accurate, than using a Moviola. A Moviola is, in essence, a viewer and a sound reader but the film is power driven, forward or backward, at both sound and variable speeds. Most of the seven stations considered here have Moviolas but they are seldom used for editing.

Two items in constant use by a television editor are "blooping" tape and 16mm artificial fades. The tape is opaque and black; the pigment is in the adherent. Though it comes in a standard half-inch size, it has been commercially cut down to the soundtrack widths of both 16mm and 35mm. It is used to bloop soundtrack at splices and also to mask unwanted dialogue or music. If carefully done, it can be used to produce the effect of a fade-in or fade-out of effects or music on the soundtrack. This is done by the artificial wiping out or wiping in on the track (Fig. 1). The tape is applied to the base side of the film. If it is applied to the other side and left there for a long time, there is a chance the emulsion will be removed along with the tape.

The artificial fades are only available for 16mm film. These come in set lengths and are easily stuck onto the picture portion of the film. There are two varieties: one a straight fade-out (which when changed end for end becomes a fade-in) and a fade-out/fade-in. In quality they do not compare to a genuine photographic fade, giving a grainy or watery appearance.

What happens when the films are edited at a TV station? Various sequences, acting scenes, and sometimes individual shots are removed, primarily to shorten the running time of the feature. With these scenes removed it is likely that certain values of the story will be altered. If nothing worse happens, certain actions will lack the motivation which was explicit in the uncut version. But when cleverly done, minutes can be removed from a scene without any apparent interruption in the continuity of the action. This kind of editing is not new. Moral and political censors have been at it for some time; deliberately altering passages in a film.

No editing whatever may be done on the titles if the contract prohibits it. An average running time for opening titles is about two minutes. However, it is possible that the titles may be removed completely and slides substituted, or just the technical credits may be cut, or each credit may be shortened, provided all of them are seen.

The next step in the editing is usually on the sections about which the editor has made notes during the screening. These scenes, and possibly sequences, may run four, five, maybe ten, or even fifteen minutes. The editor likes to make these first cuts as long as possible. Often they will extend from one optical effect to another, such as a dissolve or fade-out. If, for example, twenty-seven minutes must be cut out of a feature in a very short time, the editor cannot make a multitude of short cuts of less than a minute. It is likely that the final result would not be as clean as if the majority of the footage were taken in bigger chunks. There are valid exceptions where the plot is sufficiently complicated and the incidents are so interwoven that the only way to edit it is to shorten many scenes.

## Holding the Story Line

The TV editor's primary concern is for the line of the story. When an extensive cutting job is called for he will try to "hold the story." This means that scenes of exposition and character delineation are most likely to be sacrificed. The emphasis is on the plot. For this reason most of the first long cuts can be made in the front half of a feature. There the characters are introduced, their idiosyncracies displayed (and often reiterated), histories are told, and some nibbling is done on the main problems of the story.

Certain films for which the public feels a fond attachment and which have had a long theatrical distribution pose an added problem to the editor. The sequences which the audience remembers most warmly may have nothing to do with the advancement of the plot. There is a strong temptation to cut them out. Howls of protest usually result. To retain the sequence means that the editor must cut elsewhere and may possibly

"lose the story." The values and influences must somehow be balanced. The choice is the editor's and he does well to have good reasons behind him when making an unpopular cut.

The first long cuts are the most readily identified as suitable for excision, and the easiest to make. These cuts often take up a high percentage of the footage which the editor is trying to remove. After the first long cuts are made and there are perhaps still four or five minutes to be cut, the cuts get shorter and more difficult. More time can be spent removing the last two minutes than was spent cutting the first twenty or twenty-five minutes.

The editor tries to shorten scenes of travel. These serve as transitions between locales and often contribute to the mood and pictorial grace of a film; the action of the story is given a spatial perspective. The abridgment of these scenes is justified because the scenes are seldom climactic. A build-up of suspense may have been part of a traveling scene. This is now sacrificed to a general speed-up of the movement of the whole story.

## Types of Cuts

Dialogue is often used to assist in making a cut of a travel scene. For example, the wife of a homesteader tells him that a neighbor came by to say that there is a package for them at the postoffice in town. The package (we also learn from the dialogue) is something they have been waiting for, so the husband says he had better ride into town and get the package. Having prepared the audience with the dialogue, the editor can cut out his trip and pick up the story in town. The homesteader cannot show up at once, so a few short scenes at the saloon or hitching post before he rides into view may be used. If the trip is uneventful, the problem is easily solved.

If, on his trip, something happens to the hero, then the question arises: Can we make the same deletion? This will depend upon the importance of what happens to the hero. If the purpose is to show some aspect of his character (he strangles a rattlesnake barehanded or is frightened by a gopher), is this same trait repeated in another scene? Does it play an important part in the resolution of the story? There are no hard and fast rules to judge whether such a scene can be cut. The scene should not be vital to the development of the story, the role of the protagonist should be passive, there should be adequate references before the scene and after it, and the audience should not be able to guess that it was part of the original.

Cutting out dissolves is another common TV editing technique. A dissolve is a graceful way of indicating a change in location of the story without appreciable lapse of time. When there is no change of location after a dissolve, then the lapse of time is still not great — several minutes to several hours. In this case it is unlikely that the editor will find an opportunity to eliminate the dissolve. But when the dissolve indicates change of location, the editor may wait until the point of the scene preceding the dissolve is made, and then cut to some shot after the dissolve. The use of cuts such as this, rather than the original dissolves, tends to give the story an abrupt pace. In some instances this may well be an enhancement.

In searching for the long cuts the editor must be constantly alert for back references. These are references in the succeeding dialogue to a missing sequence. If they are not removed they become a major stumbling block to the continuity. And often they are not easy to excise. Few blunders indicate sooner that a film has been cut for TV than a back reference.

As the editing progresses the size of the cuts become smaller. Finally, the editor begins to shorten the length of individual scenes; not from the end where it might be possible to cut to "another part of the forest," but from somewhere in the middle where the location of the scene does not change. These cuts, usually running less than a minute, may call for the matching of two shots which were not adjacent in the original picture.

A match cut may be described as the conjunction when the second of two successive shots takes in a portion of the previous shot. Most problems arise when the "portion" in both shots is a human being. The audience must not be aware of any change in the position, dress or expression of the actor. For this reason the cut is safest when it goes from long shot to close-up or vice versa. There should be a change in the camera angle, as well as the composition, which will permit some latitude in the direction the actor is looking in relation to the camera. The general lighting of the two shots should not be greatly dissimilar. It may be assumed that matched cuts are not deliberately sought. The editor is usually driven to them when he must delete a back reference.

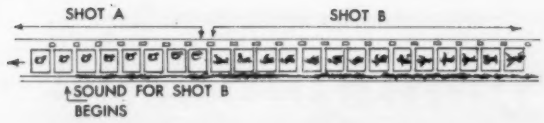


**Fig. 2. Sound advance overlap on preceding shot.**

If two shots will not match and what lies between them must be removed, the solution may lie in a cutaway. In using this technique, the editor inserts a third shot between the two which will not match. This insert, which need not match with either of the other shots, provides a time lapse to cover the change of position. This cutaway shot must be found among the material which has been deleted. Usually, after a deletion the incoming shot will have a different subject than the outgoing. A cut may begin after a particular point has been made in the dialogue, and end with the entrance of another character into the scene.

We turn now to a consideration of the soundtrack in relation to some of the deletions discussed pictorially. Because of the sound advance, which is nearly four-fifths of a foot in 16 mm and one and a quarter feet in 35mm, not all otherwise desirable cuts are possible. This is especially true of a long dialogue scene where there are few pauses. The reason for this is that the sound for a shot that should be retained may overlap some frames at the tail end of the preceding shot, which may not be wanted (Fig. 2).

The head of a cut is easier to make than the tail. The head will be the last shot to be kept before cutting. The sound for the last frame of that shot will be 26 frames ahead. If there is sound after that point, such as dialogue for the portion to be removed, it can be masked out, i.e., just the soundtrack, with the black tape. Music or effects can be faded out gradually. This is done by applying the tape so it covers more and more of the soundtrack until it is entirely masked out (Fig. 1). The fade-out should not be too quick but should last one and a half to two seconds. The same technique can be used to fade in music on an incoming shot, rather than have it blare out abruptly. The taped track fade-out is done with best effect on variable-density soundtrack and, thanks to its larger area, with greater ease on 35mm film. The adhesive fade-outs, designed to be used on the 16mm picture, can be cut down and used to fade out variable-area soundtrack. The effect is very smooth though a trifle fast.

Wherever possible the music on the track of an outgoing shot should be retained in order to have it flow over the cut. This musical bridge can be very helpful in smoothing out a cut which might otherwise appear abrupt or confusing. It gives it a continuity it doesn't deserve. The music should either be faded out by the last frame or cut to match the music in volume and rhythm on the incoming scene. If the music comes to a natural conclusion the editor can cut immediately after it and splice in his new scene. The music will appear to have been written for the cut. A few seconds may be gained by cutting the outgoing scene when, for example, a character turns and starts for the door, and the music is full. But the cut is smoother when the editor lets the track work for him, rather than against him, and waits until the music fades, if it does.

## Complexity of Editing Problems

When the editor makes his longest cuts, he may use the artificial fade-outs on the picture not only to indicate a lapse of time

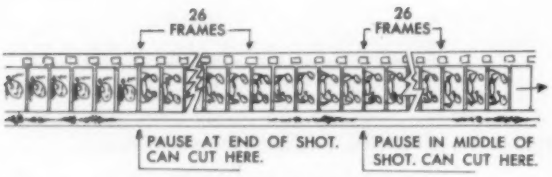


**Fig. 3. Soundtrack for a pause in the dialogue.**

but because of the soundtrack. He may have the incoming scene start with a line of dialogue. It is possible that the first few words of this line overlap the previous shot, which is not wanted. The cut is usually made, then, just before the dialogue starts; an artificial fade-out/fade-in is stuck on after the ends are spliced; the unwanted frames are covered by the opaque portion of the fade.

When it comes to making cuts in the middle of a dialogue sequence, where no artificial fades can be used, the editor is severly limited in his choice of cuts. Selecting the head of a cut is still a simple matter because all the soundtrack for the outgoing shot that he wants to keep is on that shot — not so for the tail of the cut. Here he must wait until there is a pause in the middle of a shot or at the beginning of it. The pause in the middle tells him there will be no problem of lip movement (Fig. 3). The editor needs the pause of twenty-six frames to take the place of the masked or unmodulated track at the tail end of the outgoing scene. By cutting at the end of the original pause and before the next sentence and splicing the film together this is accomplished. Without a pause there will always be lip movement in the opening frames of the incoming scene. The pause at the beginning of a shot indicates that there will be no lip movement in the opening frames and that the dialogue, always necessarily advanced, will not be printed opposite the concluding frames of the previous shot, which cannot be used. Lip movement on the incoming shot will not start until after twenty-six frames and therefore the dialogue will be printed only on the shot we want to keep.

After removing a back reference in a dialogue sequence the editor may find that the two ends of films will not match. A cutaway is called for, if there is one available. It will be a rare day when the cutaway shot he uses has an unmodulated track. Since the sound on the track is inappropriate for the new use of this shot it will have to be masked. Unmodulated track has no sound on it but, nevertheless, has a "live" quality. Track that is masked sounds dead. For this reason a cutaway shot with a masked track should not last more than a few seconds.

When making a cut in a dialogue sequence which has many individual close-up shots, the editor often looks for a reaction shot, that is, we see one character listening while the other, not in the picture, is talking. With this shot as the outgoing scene, he can make his cut and come in with a shot of the speaking character still talking. This method is similar to the cutaway except here there is useable track over the shot of the character listening.

Sometimes, for reasons of movement or a difficult track, the outgoing scene may be cut immediately after the dialogue. Thus the audience does not see the character who is talking finish his sentence. The dialogue will run over the incoming shot. This can be used effectively if the dialogue calls for a reaction shot or if a cutaway shot, following the first scene, is especially brief. It is possible, but very difficult, to make a matched action cut with the lip movement matching new words.

As there are no artificial adhesive fades available for 35mm film, several stations have tried making fades electronically at the TV switching panel while the film is being projected on the air. But timing and coordination must be so precise that this method has not met with any marked degree of success.

The degree to which the editor controls the placing of the interruptions for commercial messages depends on the importance of the program. If it is an expensive picture being shown in prime time, he may be required to have these breaks occur at, for example, fifteen-minute intervals and be allowed a one- or two-minute leeway. The requirements may be even more stringent. If, however, the feature is a re-run playing in the early afternoon, the only standard in the selection of breaks may be good taste, and the editor will have the opportunity to utilize these breaks in the cutting of the film. The commercial break can be used very handily to effect a time or place transition. If, for example, the hero-homesteader says he's going to town to pick up the package at the post office and has an adventure on the way which is not important, the editor might cut after he rides away from home and, after the interruption for the commercials, pick him up as he ties his horse up outside the post office. This operation can be abused by placing these interruptions only on the basis of the editor's need for them. They should always be spaced as evenly as possible throughout the program.

Care must be taken when editing around a break to avoid leaving in a very short shot either going into or coming out of the commercials. A one-second shot, for instance, in these positions will look like a poor editing job. A fade-out of some kind makes a smoother transition between the feature and the commercials than jumping directly into a patch of black. In this case it is practical to use an electronic fade-out because not only is there the timing for each segment of the feature but visible cues as well. It is better quality than the artificial adhesive fade, but often the switcher at the panel makes it too quickly.

## Final Timing

With the editing completed and the commercial breaks selected, the editor makes a final timing for each segment of the film, i.e., between commercial breaks and to the reel ends, and provides the director with visible cues. At several stations he prepares a complete timing run-down for the whole program, including the time the slides will be on the air. Also the feature may be provided with visual cue marks before each break and at the ends of reels for the use of the director during the broadcast. These are small circular marks in the upper right corner of the frame. A set of cue marks usually occupies four consecutive frames. They may be holes punched through the film or rings scratched into the emulsion. There is a wide variety of cuing among stations. Some make a diagonal line across the entire frame with a red grease pencil. Others use a punch which obliterates a third of the picture. The best method is one which does not affect the celluloid base of the film which, after all, is the skeleton which supports the picture.

There are usually two sets of cue marks. The first is used to start a second projector rolling. The second tells the director when to switch from the first projector, which is showing the tail end of Reel One, to the second projector which is feeding the first frame of Reel Two into the gate. There is no question that a standardized system of cuing among TV stations around the country, equipment permitting, would eliminate ragged reel ends. There is no way of masking out an unwanted cue mark without having it look as though it is masked.

With the cuing completed, the film is now ready to have the commercials inserted. After that it is ready for the air.

## Esthetic Values

The TV editor's aim is to hold the story while cutting the film to the required time. What remains after editing is often the skeletal action of the story, bereft of subtleties and psychological significance. The better the film, of course, the more responsible is the editor's approach to it. It is possible that a feature may be improved by its TV adaptation. If it is long, sluggish, and miasmally sentimental it may be cut into a more entertaining shape. Ultimately, as the TV editor's work improves he approaches obscurity. The best job is least noticed.

The most common errors in the editing of feature films for television are:

(1) *Mismatched action.* The cause for this is either carelessness or the naivete of the editor. If a prospective cut will not match correctly then, of course, it should not be made. Since the picture will only be enlarged to the size of a twenty-one inch TV receiver in comparison to many times this for a motion-picture theater the editor may try to convince himself that "no one will notice it." Since a feature is seldom checked after being cut, small errors may go undetected in the ground glass of a film viewer.

(2) *Lip movement.* The film has been cut to keep the desired dialogue, ignoring the lip movement on the first twenty or twenty-six frames which went with the dialogue cut out. To prevent this there must be a pause before the speech to be kept.

(3) *Sound after picture.* Most commonly this occurs just before the commercial breaks. It is easily corrected by masking the track for the length of the sound advance.

(4) *Unnatural dialogue.* This error is most likely to occur when the editor is working with a viewer and sound reader rather than a Moviola. With the former it is necessary to wind the film manually at sound speed in order to get the correct expression from the actors' voices. The mistake happens when a cut is made within a dialogue sequence and, though the new sequence of the lines makes sense, the "reading" of the incoming speech is incongruous to what preceded it.

After a feature has been cut and broadcast it may be restored to its original condition and shipped back to the distributor. Some stations restore the cut portions after every broadcast, having it cut again, perhaps by another editor, when it is next scheduled even though the film may never leave the station.

There is a problem attached to the filing and storage of the cuts which have been removed from many features. This is one of the main reasons why some stations prefer to restore the cuts after each play. It prevents them from getting lost. Some stations mount the cuts, one after the other, on a new reel. Others flange them and store them in cans. Some have a specific technique for marking the cuts and where they occur in a feature; others have none. One of the clearest methods of handling cuts is to number them as they are removed. A six-inch stripe is made

**Fig. 4. Marking film at cuts.**

over the sprocket holes on each side of the splice with Movietone ink (blooping ink). With a razor blade or sharp stylus the number of the cut can then be scratched into the blacked area. Not only can the cuts be easily and quickly identified but, after a film has been re-re-edited, it is possible to tell which cuts have been restored and which have not. If the black strip does not extend on both sides of the splice, the cut has been returned to the feature (Fig. 4).

By far the greatest number of features shown on television, even in the New York area, are on 16mm film. Of the seven stations considered in this paper, five use 16mm features exclusively. The other two use both in a varying proportion. The principal reasons for using 35mm on television are better quality and the ability of the film to stand up under repeated projection.

The editing of a feature film is a necessary operation with our present system of commercial telecasting. This system involves the division of the day into set program lengths so that each program must begin and end at a specified time. The effect of this re-editing on the final product, at best, will speed up the action of an overly detailed story and, through simplification, enhance one-dimensional characters. At worst, it will distort the meaning of a story, due primarily to the deletion of expository scenes delineating motivation, or leave apparent lacunae in the continuity of the tale. By improved technique the images may flow as smoothly on the TV screen as the audience expects them to do in a movie theater, but scene settings, moods and refinements will be sacrificed to preserve the skeleton of action.

Much ingenuity has been expended on this craft but still it remains more an art than a science. The judgment of the individual editor in selecting the scenes to be removed, restricted by the physical form of the film itself and established cinema techniques, is the significant variable.

# Evaluation and Control of Brightness Levels for Television Studio Lighting

By ROLLO GILLESPIE WILLIAMS

**One of the best known units of measurement in the practice of applied lighting is the foot-candle. It is used to measure incident lighting density and corresponds to a uniformly distributed light flux of one lumen per square foot. However, we are usually concerned with incident light only as a means of obtaining surface reflections and the foot-Lambert then becomes an important unit of measurement, since it represents the *apparent* foot-candle, or the value of incident light in foot-candles multiplied by the reflectance factor of the diffusely reflecting surface.**

**It is shown that knowledge of foot-candle data alone does not necessarily lead to an accurate calculation of foot-Lambert values where colored surfaces are concerned. Color is discussed from the standpoint of spectral distribution in the illuminant and its effect upon brightness reflectance of colored surfaces. It is also shown that apparent brightness values as seen by the eye do not correspond to the actual values.**

IT IS OFTEN believed that the foot-candle represents an absolute value from which footlambert values can be calculated for both color-selective and non-selective surfaces, but this is true for colored surfaces only if the luminous reflectance of the lighted surface is rated under light of the same spectral distribution as the light source in question. Thus while the luminous reflectance of neutral gray colors remains unchanged under all types of illuminants, the difference in the luminous reflectance of colors under different light sources becomes more marked as the colors become more saturated. This means that a blue surface diffusely reflecting only 380-500 mμ can have nearly twice the surface brightness under cool white fluorescent lighting compared with 2900 K tungsten filament lighting for a specific foot-candle density. Conversely an orange-red surface diffusely reflecting only 600-760 mμ can have less than a quarter of the surface brightness from a cool white fluorescent compared to tungsten filament lighting for the same foot-candle density. These differences will be smaller if the colors are desaturated, but they can be sufficient to cause important differences in foot-Lambert values under various types of illuminants.

Presented on October 7, 1959, at the Society's Convention in New York by Rollo Gillespie Williams, Director of Color Research, Century Lighting, Inc., 521 W. 43 St., New York 36.
(This paper was first received on October 7, 1959, and in final form on June 13, 1960.)

### Lumen Output of Light Sources

The luminous output of light sources is usually rated in lumens. The lumen output of a source is calculated by multiplying the radiant energy at each wavelength by the factor of eye sensitivity at that wavelength. Figure 1 shows the standard (CIE) eye sensitivity curve, which gives the relative capacity of radiant energy at different wavelengths to produce visual sensation. Maximum sensitivity takes place at 555 mμ, which is in the yellow-green portion of the spectrum. Thus, a light source emitting all visible radiation at (or near) 555 mμ will have a higher lumen rating than a source giving the same wattage of visible radiation but elsewhere in the spectrum. For example, a green fluorescent lamp with 6.67 w of visible radiation is rated at 3000 lm because most of its radiation is between 500 and 600 mμ; however, a daylight fluorescent lamp with a visible radiation of 8.04 w is rated at only 2325 lm because much of its radiation is also in the 380–500 and 600–760 mμ parts of the spectrum.

The rating of the luminous output of a lamp in lumens does not provide information concerning spectral distribution and will be a true guide to its illuminating power only for neutral white and gray surfaces, or when the luminous reflectance of a colored surface has been calculated for a spectral distribution corresponding to the light source in question. Obviously it would be wrong to consider a sodium-vapor lamp with its very high lumen efficiency for the illumination of

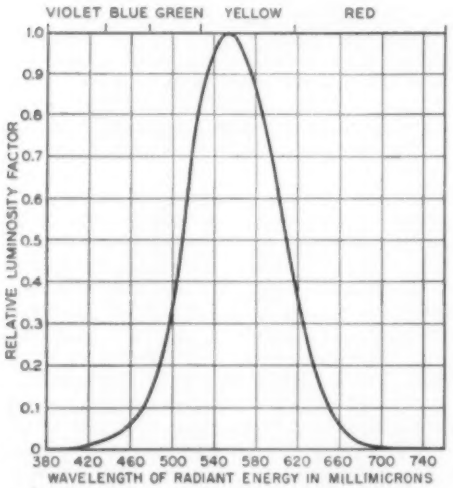


**Fig. 1. The standard (CIE) luminosity curve, showing the relative sensitivity of the human eye to different wavelengths of radiant energy. (Courtesy *IES Lighting Handbook*)**

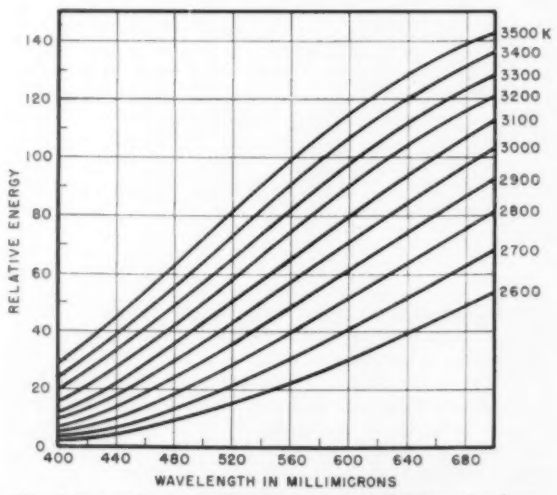


**Fig. 2. Spectral energy distribution in the visible region from tungsten filaments of equal wattage but different temperatures. (Courtesy *IES Lighting Handbook*)**

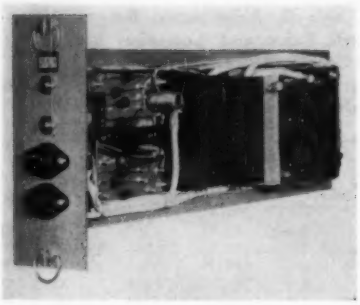

**Fig. 3. A C-core remotely operated silicon controlled rectifier plug-in type dimmer, available in sizes 2–12 kw. (Courtesy Century Lighting, Inc.)**

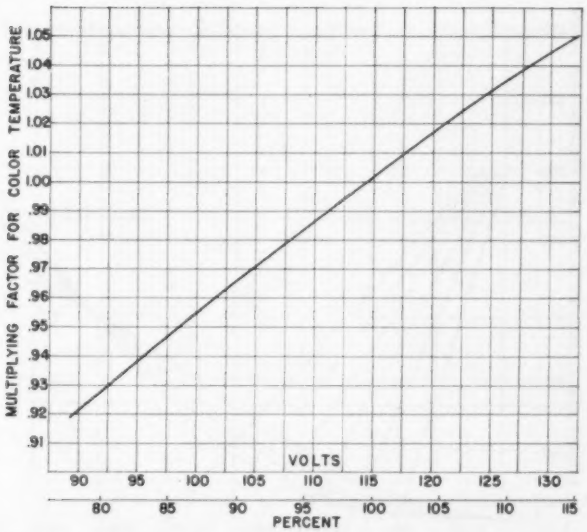


**Fig. 4. Variation of color temperature with change of voltage — 100- to 130-v types.**

blue or blue-green surfaces, since the entire luminous output is radiated at a double line in the yellow region of the spectrum at 589.0–589.6 mμ. Such a spectral quality in spite of its high efficiency of 55 lm/w would be useless for the illumination of surfaces reflecting say only 3805–50 mμ.

As stated above, a foot-candle corresponds to one uniformly distributed lumen/square foot of illuminated surface. It may be shown that a source of one mean spherical candlepower radiates a flux of 12.57 lm. However, when it is possible for the luminous reflectances of specific surfaces to vary under illuminants of different spectral quality, then accurate lighting calculations cannot be made from lumens alone, and it is necessary to consider the spectral distribution of the radiation within the visible spectrum.

### Reflectance Efficiencies

Lighting calculations are often made on the basis of stated luminous reflectance efficiencies. These values usually correspond to the *Y* luminous reflectance value (CIE chromaticity diagram), which is obtained by dividing the total of the *Y* column by the *Y* value of the illuminant, which in the case of each of the standard CIE illuminants A, B and C is 100,000. Thus if the value of *Y* for the test sample and a CIE standard illuminant is say 16,884, then the reflectance factor is 16,884/100,000, or $Y = 0.169$. From this it will be obvious that the value of *Y* may vary if some other type of illuminant with a different spectral distribution, is employed.

### Color Temperature

Most of the lighting equipment in TV studios utilizes tungsten filament lamps and it may be erroneously assumed that with incandescent lamps the differences in lumen output and color temperature between different types will have little effect on spectral distribution and consequent reflectance values. That this is not the case is illustrated by Fig. 2, which shows the spectral energy distributions for tungsten filament lamps of the same wattage but different color temperatures (K). It is well known that the lumen output per watt increases as color temperature is increased, and this is evidenced in these curves. But it is also clear that the various radiant energy outputs and different spectral distributions result in the ratio of (red-orange) light at 640 mμ to (blue) light at 440 mμ, changing from 10:1 with the 2600 K lamp to nearly 3:1 for the 3500 K lamp. Such a change can have marked effects on the surface brightness of highly saturated colors, and even on many pastel colors.

### Spectral Energy Bands

One useful way of simplifying the consideration of spectral energy distribution, is to divide the visible spectrum into three bands:

380–500 mμ (Violet, Blue)
500–600 mμ (Green, Yellow)
600–760 mμ (Orange, Red)

Consideration of the visible radiation in these bands provides a useful guide to the effect of spectral energy distributions both on appearances and upon brightness values.

### Dimmers and Color Temperature

Dimmers are frequently employed to vary the luminous output of light sources. These may be autotransformer, resistance, saturable reactor, thyratron tube, magnetic amplifier or controlled rectifier type; but in each case, with tungsten filament lamps, they operate so as to vary the voltage to the lamps. Reduction of voltage reduces the operating temperature of the lamp filament, resulting in both a reduction in color temperature rating and in a loss of light output. A remotely operated silicon controlled rectifier type of dimmer suitable for use in TV studios is shown in Fig. 3.

**Table I.**

| Voltage, % | Lumen output, % | Approx. color temp., K |
|---|---|---|
| 100 | 100 | 3200 |
| 82 | 50 | 3000 |
| 67 | 25 | 2800 |
| 50 | 9 | 2600 |

Figure 4 shows the variation of color temperature with moderate changes of voltage for 100- to 130-v tungsten filament lamps. Thus an 18% drop in voltage reduces the color temperature of a lamp to 93.5% of normal or a 3200 K lamp to 3000 K. The 18% voltage drop will also cut the total lumen output of the lamp to 50% of full light. Other figures will be seen in Table I.

Figure 5 shows variations of spectral distribution for different color temperatures in terms of μw/100 A/lm. These curves serve as a guide to what happens to the spectral distribution of tungsten filament lamps when they are dimmed.

Consideration of the factors so far discussed will enable us to calculate brightness values with due regard to spectral reflectances and the spectral quality of the illumination, and with maximum lighting efficiency.

### Apparent Brightness Magnitudes

Foot-Lambert values do not have the same value to the human eye as the actual figures would suggest. Thus with a scale of luminous reflectance, seen against a medium or light background, a surface that looks midway between black and white will reflect about 20% of the incident light rather than the 50% it appears to reflect. An important example of re a-

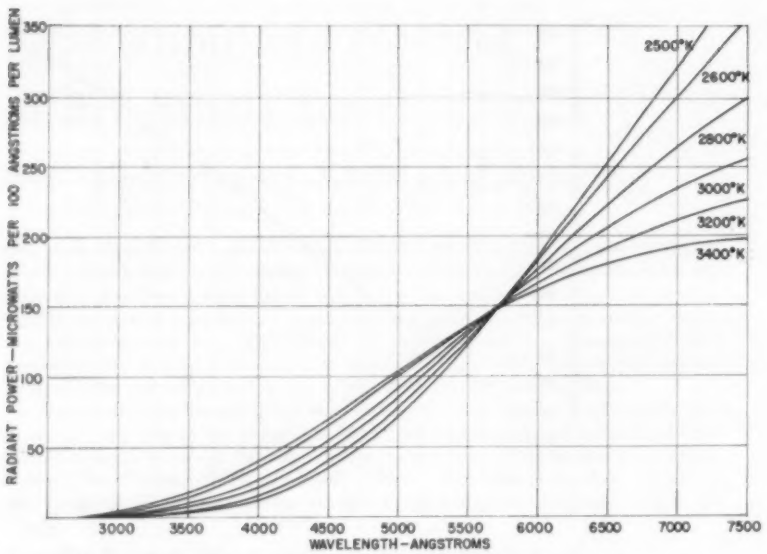


**Fig. 5. Spectral distributions for various color temperatures of tungsten filament lamps.**

**Table II. Relationship Between Munsell Value and Luminous Reflectance.** (Courtesy *IES Lighting Handbook*)

| Munsell value | Luminous reflectance* | Munsell value | Luminous reflectance* |
|---|---|---|---|
| 10.0 | 102.6 | 7.8 | 55.6 |
| 9.9 | 100 | 7.7 | 53.9 |
| 9.8 | 97.4 | 7.6 | 52.3 |
| 9.7 | 94.9 | 7.5 | 50.7 |
| 9.6 | 92.4 | 7.4 | 49.1 |
| 9.5 | 90 | 7.3 | 47.5 |
| 9.4 | 87.7 | 7.2 | 46 |
| 9.3 | 85.3 | 7.1 | 44.5 |
| 9.2 | 83.1 | 7.0 | 43.1 |
| 9.1 | 80.8 | 6.5 | 36.2 |
| 9.0 | 78.7 | 6 | 30 |
| 8.9 | 76.5 | 5.5 | 24.6 |
| 8.8 | 74.4 | 5 | 19.8 |
| 8.7 | 72.4 | 4.5 | 15.6 |
| 8.6 | 70.4 | 4 | 12 |
| 8.5 | 68.4 | 3.5 | 9 |
| 8.4 | 66.5 | 3 | 6.55 |
| 8.3 | 64.6 | 2.5 | 4.6 |
| 8.2 | 62.7 | 2 | 3.1 |
| 8.1 | 60.9 | 1.5 | 2.0 |
| 8.0 | 59.1 | 1 | 1.2 |
| 7.9 | 57.4 | 0 | 0 |

*** Relative to smoked layer of magnesium oxide:** To obtain *absolute* luminous reflectance, multiply values given by 0.974 MgO, usually used as 100% reflectance, is 9.9 on the Munsell scale, in which absolute white is 10.0.

tionship between visually equal steps of lightness and luminous reflectances is seen in the Munsell Value Scale, figures from which are shown in Table II. It is interesting to note that value 7 is high in the lightness scale yet it reflects only 43.1 of the incident light. Also there is much greater visual difference for a given percentage of reflectance at the bottom of the scale than at the top.

It may be said that in television work we are not so concerned with brightness values as they appear to the eye as we are to camera response.

### Spectral Sensitivity of Camera Tube

The camera response to spectral and brightness values is a most important factor in the chain of technical events that culminates in a picture on the viewer's television screen. It is impossible to approach studio lighting in a scientific manner without taking into account the characteristics of camera response.

Figure 6 shows the spectral sensitivity characteristic of the type 5820 image-orthicon tube with and without filter. Curve A gives the spectral response of the tube without correcting filter and curve B shows the spectral response when a Wratten No. 6 filter is used with it. The eye sensitivity curve shown in Fig. 1 is also seen as Curve C in conjuction with the relative sensitivity scale on the right. Curve B more closely approximates the eye sensitivity curve than the unfiltered Curve A, but there are obvious differences in spectral response that must be taken into account, if lighting values are to be used for maximum effect.

### Optimum Pictorial Effect

It may be helpful in getting maximum pictorial effect on the viewing screen if the optimum brightness and contrast values for a scene are calculated, so that the lighting director can use his talents, experience and skill to approach as nearly as possible to the optimum effect. A knowledge of the visual adaptation of the human eye to brightness is a most important step in this direction. The eye evaluates brightness values in a very different manner than a photometer, and much research has been carried out in recent years on this subject.

### Hopkinson's Curves

A series of curves was presented in 1941 by Hopkinson, Stevens and Waldram, relating the luminances in the visual field, the adaptation level of the eye and a scale of what has been termed "apparent brightness." It was found that values of apparent brightness are related to the state of eye adaptation and to various luminances in the field of vision. Each curve gives values of "apparent brightness" corresponding to one state of eye adaptation and to various luminances in the field of vision.

The scale of apparent brightness used with these curves was determined by a contrast scaling technique in which the brightnesses of two small patches were viewed and compared in an adapting field of selected brightness. The brightness of one patch was raised until there was a just noticeable difference compared to the other patch. The darker patch was then raised in brightness until it just noticeably exceeded the brightness of the other. This process was repeated until a complete scale of contrast steps was obtained in conjunction with one brightness value of field luminance, ranging from the maximum brightness available from the equipment down to apparent black. The procedure was then repeated with other values of field luminance.

It was noted by Hopkinson that when the 1941 data were applied to the lighting of buildings discrepancies were indicated, more especially in connection with the apparent magnitudes of high brightnesses which, in practice, were found to be less influenced by field luminances than indicated by the 1941 curves. Further research was therefore carried out, and recently a new method of testing was employed.

This new method and the data resulting from it are described in a paper entitled "Adaptation and Scales of Brightness" presented by R. G. Hopkinson at the CIE Session in Brussels, 1959. A brightness magnitude scale in accordance with the judgments of observers was determined and this replaced the arbitrary scale of the 1941 data which was based on "just noticeable differences." The new scale was required to show that an apparent brightness of 4 could appear twice as bright as an apparent brightness of 2, and an apparent brightness of 40 would appear twice as bright as one of 20.

The data determined by these new tests are reproduced in Fig. 7, and represent a very valuable contribution to the science of applied illumination.

The new data were determined by asking the observer to view a single 2° patch in the center of a large field of adaptation luminance of selected value. The patch was then varied in brightness in random order and the observer was asked to assign a number representing his

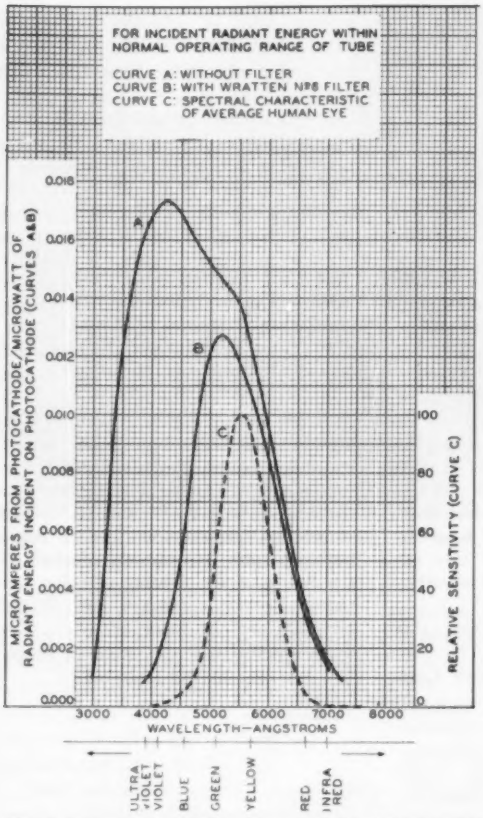


**Fig. 6. Spectral sensitivity characteristic of Type 5820 with and without filter. (Courtesy RCA Electron Tube Division, *5820 Image Orthicon*)**

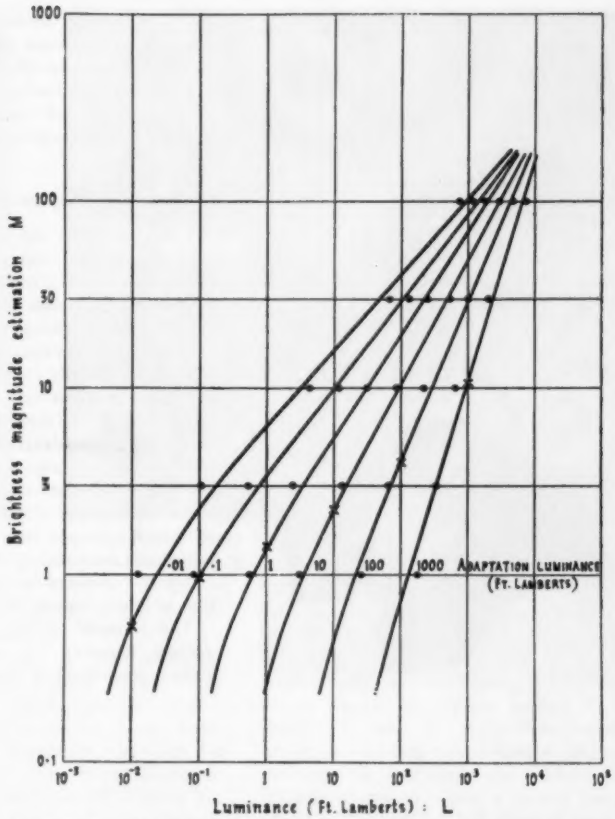


**Fig. 7. Scale of apparent brightness determined by brightness magnitude estimations (2° source in large adapting field). (Courtesy Dr. R. G. Hopkinson, Dept. of Scientific and Industrial Research, Building Research Station, Garston, Walford, Herts., England, from his paper "Adaptation and Scales of Brightness" given at CIE XIV Session, Brussels, 1959.)**

sense of the magnitude of each brightness. The only stipulation was that high numbers should be given to high brightness and that as far as possible the number chosen should be in direct relation to the seeming magnitude of the perceived brightness.

The results are most interesting. For example, it will be seen from Fig. 7 that when the adaptation level of the eye is 1 ft-L, then a small patch of 10 ft-L will have an apparent brightness magnitude of 5.6, whereas a similar patch of 100 ft-L brightness (seen under the same viewing conditions) would have an apparent brightness magnitude of 18. However, should the same two brightnesses be compared when the adaptation level is 10 ft-L, then the apparent brightness magnitudes would be 2 and 10 respectively. Conversely, if viewed when the adaptation level of the eye is 0.1 ft-L, then the apparent brightness magnitudes would be 10 and 30 respectively.

Referring to the data reproduced in Fig. 7, Dr. Hopkinson states that "the apparent brightness of any part of any visual field can be determined from the data, assuming no simultaneous contrast or brightness constancy effects. For example, a luminance of 5 ft-L, say a bright patch on a street surface when the adaptation level is 0.01 ft-L, can be found from the appropriate adaptation curve to have an apparent brightness of 10. This is, for example, the same value 10 as the apparent brightness of the moon seen in daylight on a bright day (luminance of moon approximately 1000 ft-L, seen in surroundings also of average brightness 1000 ft-L) with white clouds, blue sky."

From the foregoing it will be obvious that foot-candle and foot-Lambert values have no absolute value as far as the *appearance* of brightness is concerned, and that different but related brightness values can vary considerably in their "apparent" brightness magnitudes. In addition to the factor of eye adaptation already considered there are also other factors that may influence the apparent magnitudes of brightnesses, as, for example, effects from simultaneous contrast or from the factor of brightness constancy; but if proper allowances are made for these factors then the data reproduced in Fig. 7 can be very valuable as an aid to calculating the actual lighting values necessary to produce desired apparent brightness magnitudes.

### Picture-Tube Contrasts

Since the basic purpose of TV studio lighting is to produce an effective brightness pattern on the picture tube, these curves may provide helpful information as to optimum visual contrasts in the picture.

### Color Rendition

The author has avoided any mention of color in the sense of accurate color rendition or relationship, since this is the subject for another paper. Color has been discussed from the standpoint of spectral distribution in the illuminant and its effect upon the brightness reflectance of colored surfaces. It has been shown that knowledge of foot-candle densities alone does not necessarily lead to an accurate calculation of foot-Lambert values where colored surfaces are concerned, and also that apparent brightness values as seen by the eye may not correspond to the actual values. It is hoped that the curves illustrating this paper will be of assistance.

**Fig. 8. A remotely operated, moving-shutter type brightness control is included in this 2-kw spotlight along with remotely controlled mechanisms to pan, tilt, focus, raise and lower the unit. (Courtesy Century Lighting, Inc.)**

**Brightness Control Devices**

The changes in the spectral distribution of tungsten filament lamps produced by dimming raises the important question as to whether the industry should accept the challenge to find other methods of brightness control than by varying the supply voltage to the lamps. For color work it has frequently been found desirable to restrict color temperature change to about 200 K which in turn means a voltage reduction of only 18–20%. Black-and-white work will tolerate much larger differences, but none the less if optimum results are to be obtained, it is necessary to take into account the changes in spectral distribution at lower voltage values.

The August 1959 issue of this *Journal* contains an article by the author describing a new Punch Card System that in addition to normal dimmer operation can also regulate the relative intensity of four light sources in a lighting unit so that the spectral quality can be controlled at any intensity. This Punch Card System was also described as being able to control all movements of electrically operated remote control spotlights. Spotlights of this type can have a moving shutter type brightness control incorporated in each spotlight. This enables the quantity of light output to be regulated without change in spectral quality. (See Fig. 8.)

It may be interesting to note a statement in the Progress Committee Report in the *Journal* for May 1954:

"The Century Lighting Company has done considerable work with remote-controlled incandescent lamps for television stage lighting. The facilities include remote control of intensity without change of color temperature or distribution pattern, an important feature for the future of the lighting of color television. Remote controlled pan tilt and elevation are also incorporated in these units, together with the necessary simplified operator control pedestal."

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**TRANSLATION**

# The Xenon Short-Arc Lamp in Motion-Picture Projection

By B. SEEGER
and W. JAEDICKE

*Translated by Norman Macbeth*

**The development of a series of xenon gas discharge lamps, with excellent color properties, has opened up new fields of application for artificial lighting.**

XENON LAMPS are known as short-arc lamps of various sizes and wattages, long-arc lamps of high wattage with water cooling, and air-cooled long-arc wall-stabilized lamps of extremely high wattages, such as 6, 10, 20 and 65 kw.

These xenon lamps are being used increasingly for fade testing, stage lighting, reproduction of colored and black-and-white illustrations or transparencies in graphic arts, searchlight equipment, motion-picture projection and many other fields, including instrumentation.

A translation from *Kino-Technik, 13:* No. 3, pp. 55–59, 1959, received on December 31, 1959, from Norman Macbeth, Macbeth Corp., P.O. Box 950, Newburgh, N.Y.

The high-pressure xenon discharge lamp produces in the visible spectral range a continuum on which only a few lines are superimposed, such as in the blue area of the spectrum. These lines were superimposed on the continuum. This spectral composition renders colors more similar to daylight of approximately 6000 K than any other artificial light source.

Its excellent color-rendering qualities make it an ideal light source for use in motion-picture projectors, particularly for the projection of color film. Because of the particular problem involved in motion-picture projectors, special types of xenon short-arc lamps were made with a small electrode spacing and very high brightness of arc. In Europe large numbers of motion-picture projectors are equipped with xenon short-arc lamps of 900- and 1600-w size, with maximum power consumption of 1200 w and 2100 w, respectively.

Initially, when the xenon lamps were used in motion-picture projectors, they were conversion installations in housings which originally employed carbon arcs. Since the xenon lamp requires high voltage during the ignition cycle, the igniter had to be placed in proximity to the lamp. The optical design of the projector had to be altered to take into account the difference in the brightness distribution of the xenon arc, as compared to the brightness distribution of the carbon arc. The excellent results were obtained with reconstructed carbon-arc projectors, using xenon lamps, and in due course special lamp housings were designed. Although, in principle, it is possible to convert existing carbon-arc

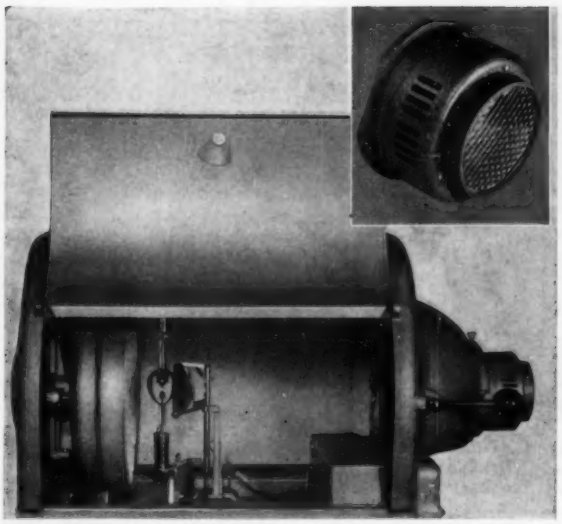

**Fig. 1. Zeiss Ikon Xenon Lamp Housing; Xenosol Mfg. Co. honeycomb condenser.**

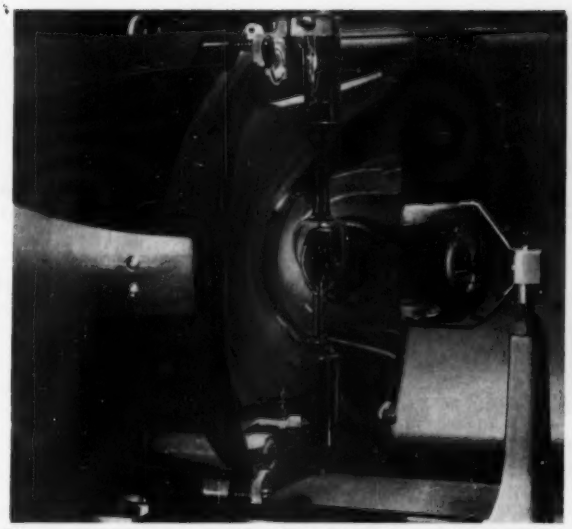

**Fig. 2. Xenon lamp housing BL 9 X for the projectors of the Eugen Bauer GmbH.**

housings for operation with xenon discharge lamps by equipping them with a xenon light kit, an igniter, and a new optical system, maximum exploitation of xenon lamps cannot be accomplished except by building special lamp housings for the xenon lamp itself.

There are many ways to obtain optimum utilization of the xenon luminous flux and even illumination of the shutter aperture. One is the honeycomb condenser; some manufacturers prefer thoric lenses and others a main and auxiliary mirror or deep ellipsoid mirrors.

To convert a projector from a carbon arc to a xenon lamp, it is necessary to provide means for reducing ripple of the lamp current to less than 10%. The ripple is defined as $i_{max} - i_{min}/i_{max} \cdot 100\%$.

A practical advantage of using xenon lamps is easy operation, compared to the carbon arc which needs continuous trimming and replacement. The xenon lamp needs only to be inserted and adjusted in the lamp housing after which it will operate for a period of $1\frac{1}{2}$ to 2 years, depending upon the number of daily performances. No other maintenance is required. Inasmuch as the lamp burns within the enclosure of the quartz envelope there are no smoky gases or ashes, and consequently no dirt deposited on the mirror and optical system.

Remote control of the xenon lamps and their long running time make possible, for the first time, almost automatic motion-picture projector operation. As such, the operator has much less work, and can devote his time to the quality of the picture or to other tasks in the projection room. Many years of use in motion-picture projectors have proven that these lamps do not damage cold mirrors, so that the life of the mirrors is practically unlimited.

The advantages of the short-arc xenon lamp, enumerated above, have induced many motion-picture theater owners to change over to xenon lamp operation. So convinced are they of their value that in West Germany hundreds of motion-picture houses are now operating with XBO xenon lamps. In the beginning, the high color quality and optical quality of the lamps dictated their use. An additional incentive has proved to be the lower operating cost. An important reason for this is the long life of the lamp. Originally, Osram, the manufacturer, indicated a life of 800 hr. In 1956 this was increased to 1200 hr. With the experience gained from thousands of lamps in use, the original conservative statements concerning xenon lamp life have been revised to an average life of 1500 hr, in some cases even more than 3000 hr, and a warranted life of 1000 hr.

The brightness achieved on the screen by use of a 900-w xenon lamp is sufficient for the small motion-picture theater. For a medium-sized screen of 4.5 to 8 meters, good brightness is obtained with the 1600-w xenon short-arc lamp.

Logically, larger motion-picture theaters, with screens in excess of 8 meters, wish to operate with xenon lamps. Since xenon short-arc lamps in excess of 1800-w are not available at the present time, attempts to use the 1800-w lamp have been made by pulsing the lamp twice for each frame.

Unfortunately, xenon short-arc lamps, as they are presently manufactured, deteriorate quickly under this type of operation, and this method is not employed with the standard lamps. Special pulsed lamps have been built for this purpose but difficulties persist. A small pulsed lamp of high wattage can be operated only with the aid of water cooling, and even with cooling, the lamp has a shorter life. Water cooling of a discharge lamp in a motion-picture projector creates considerable inconvenience in operation and results in additional cost. To cool a pulsed lamp requires a supply of 300 liters of water per hour. Unless the water is thoroughly filtered, deposits will occur in the lamp which will quickly reduce the light output and cause shorter life.

Pulsed discharge lamps require an electronic system for operation. Such a system is not now compatible with carbon-arc lamps, nor familiar to projectionists. Thyratron tubes are used in the electronic system for pulsing lamps and provide an additional source of trouble, as well as expense in replacement.

Even though the impulse water-cooled xenon lamps have a short life, experience is indicating that some of them are replaced sooner than their rated life, and this involves careful inspection by the projectionist to make certain that the lamp has not failed prematurely.

This is avoided when using a xenon lamp with continuous discharge such as the xenon short-arc lamps. The replacement of these lamps can be made during the off periods, or between performances. It is easy to note the end of the xenon lamp's economic life by examining the blackening of the lamp or simply by keeping a record of the number of hours that the lamp has been in operation.

Some persons have assumed that xenon lamps may explode because of high gas pressure. Experience, however, has shown that occasional explosions occurred during the early days of using these lamps, but that they do not occur

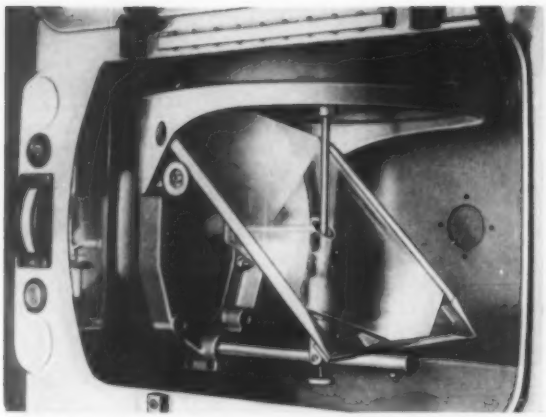

**Fig. 3. Lamp housing FH 99 X of Frieseke & Hoepfner GmbH, Erlangen.**

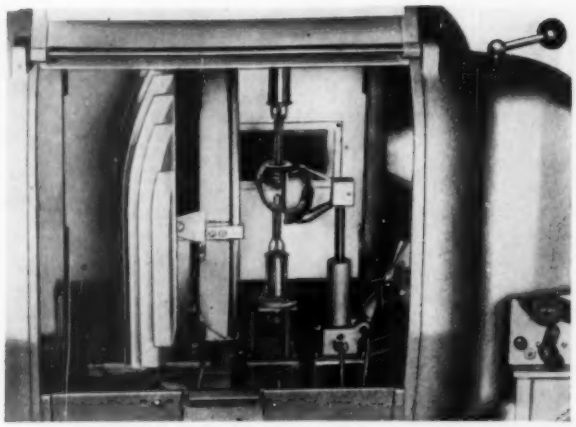

**Fig. 4. Lamp housing of the Askania-Werke AG with xenon lamp XBO-1600 W.**

in present-day lamps. To avoid accidents during transportation or installation, each lamp is provided with a protective cover which is removed only after the lamp has been installed.

Long experience has proven that ozone is produced only when the lamp is first started and ceases almost completely after a few minutes when the operating temperature has been reached; thus, there is no damage to any component part of the projector or the projection room, or discomfort to the projectionist.

The question of cost must be examined from different aspects. First, there is the original cost. As stated previously, any existing carbon-arc projector may be converted into a xenon lamp projector by removing the housing and installing an attachment to reduce ripple from the rectifier. The changeover from a 900-w xenon lamp motion-picture projector to a 1600-w xenon lamp, for increased screen brightness, requires that the rectifier be replaced with one of a larger size. Conversion to pulsed operation necessitates a completely new motion-picture projector and a new power supply, plus water-cooling pipes, etc., so that comparison with the cost of an ordinary conversion of an existing installation to a convection-cooled xenon short-arc lamp can hardly be made. As original equipment, where an entirely new projector is provided with special power supplies, etc., installation cost compares favorably with that of other types of installations, with the added advantage of lower operating cost and simplified operation. Table I shows the actual operating cost for various cities in Germany, using 1600-w xenon lamps in motion-picture projectors. Local power rates have been used.

In connection with this table, it should be borne in mind that for 1564 hours' theater operation per year xenon lamps in both projectors have to be replaced only about every two years. It is therefore necessary to have, in reserve, only one spare xenon lamp. Amortization of the lamp reserved as a spare, as well as that of the lamps in operation, has been included in the computation.

In many cases, however, no new xenon lamp is kept in reserve but merely a used lamp which has reached a rated life of 1500 hours and has been replaced but is still usable in the event of breakdown. This is also possible until a new lamp is delivered and the used lamp can again be reused as a spare.

A point not previously discussed is that xenon short-arc lamps hardly change in color quality during their entire life, and that there is no change in color quality with a variation in voltage.

For all of the above reasons, it appears that the xenon short-arc lamp has the best features as a light source for motion-picture projectors, particularly with color film.

**Table I. Operating Costs in Motion-Picture Projection With Xenon Lamps for Each Operating Hour.**

| Yearly operating hours | Xenon lamps 1600-w life duration 1000 hr | 1500 hr |
|---|---|---|
| 1. Berlin | | |
| 1564 | 1.40 | 1.07 |
| 2294 | 1.31 | 0.99 |
| 2. Cologne | | |
| 1564 | 1.48 | 1.15 |
| 2294 | 1.38 | 1.05 |
| 3. Munich | | |
| 1564 | 1.39 | 1.06 |
| 2294 | 1.32 | 1.00 |
| 4. Stuttgart | | |
| 1564 | 1.45 | 1.12 |
| 2294 | 1.36 | 1.04 |

*Notes:* Included in column 2 is a standby lamp. The operating hours per year are obtained as follows: (a) 6 days weekly, 2 shows daily, plus an extra show one day — 782 shows (2 hr each); (b) 6 days weekly, 3 shows daily, plus an extra show one day — 1147 shows (2 hr each).

# Apparent Movement in Motion Pictures

By EDWARD LEVONIAN

**The general acceptance of the wide screen has increased the probability with which normal perception of apparent movement can give way to discrete movement, the disconcerting perception of "skip" or "jump" of the projected image when it moves too rapidly across the screen. This paper not only reviews some of the theories and characteristics of apparent movement but also discusses ways in which discrete movement may be controlled.**

PROJECTION in professional motion pictures involves the successive presentation of 24 physically different still pictures per second, each being presented three times. As long as the projection and viewing conditions remain within certain limits, the displaced image on the screen will appear to move smoothly; this phenomenon will be referred to as apparent movement. However, if certain limits are exceeded, the screen image will appear to move in a discrete fashion with a frequency of 24 "skips" per second; this phenomenon will be referred to as discrete movement. In general, discrete movement is more noticeable with wide-screen projection.

A number of factors contribute to the perception of apparent or discrete movement, factors such as the amount of displacement between successive frames, the number of shutter interruptions per frame, the relative intensities of object and background, the form of the object and background, the familiarity of the object to the spectator, the placement of the spectator, the intent or attitude of the spectator, and visual angle.

The factor which most readily lends itself to the practical control of discrete movement is visual angle, the angle at the spectator formed by the displacement of an image on the screen between two successive frames. Although the relationship between apparent movement and visual angle has been little explored, there is every indication that this relationship is not simple. This is hardly surprising in view of the many complications of apparent movement, ramifications which may best be indicated by a brief review of some theories and characteristics of apparent movement.

### Theories of Apparent Movement

Attempts have been made to account for apparent movement according to both physiological and psychological theories. These two classes of theories will be reviewed, beginning with some of the physiological theories.

A contribution by Edward Levonian, Assistant Research Psychologist, Institute of Transportation and Traffic Engineering, University of California, Los Angeles 24.
(This paper was first submitted on September 21, 1959, and in final form on June 6, 1960.)

It seems most appropriate to begin with configurational theory, for the configurational, or Gestalt, school grew out of Wertheimer's investigation of apparent movement. One basic concept of configurational theory is the *gestalt*, the spatial configuration of the stimulus as well as all the factors which may change the experience of it.[1] This concept, as applied to apparent movement, involves such factors as dark interval, exposure time and intensity, and the magnitude of the movement. Another thesis of configurational theory is isomorphism: the parallelism of the physical properties of the nervous system with phenomenal correlates. As applied to apparent movement, this thesis leads to an attempt to find a relationship between neural mechanisms and apparent movement.

One such attempt, contributed by Köhler[2] (as cited by Neff[3] and described by Osgood[4]), involves a neural hypothesis of apparent movement based on the interaction between excitation peaks in area 17 of the occipital cortex. Consider two successive excitation peaks represented in proximity on the occipital cortex. Imagine each representation as consisting of an intensity pattern which (a) increases with time to a maximum value, (b) decreases with distance from its epicenter and (c) decreases with time after it has reached its maximum. At an instant of time after the initiation of the second pattern, a third peak results from the summated effect of the first pattern (corresponding to the preceding film frame), which is now decaying, and the second pattern (corresponding to the present film frame), which is now being generated. As time progresses, this summated peak moves from the first epicenter to the second, and the neural correlate of apparent movement would be this moving peak. However, this is only an hypothesis, and Osgood emphasizes the fact that the true relationship between neural mechanisms and apparent movement is unknown at the present time.

Further physiological evidence is supplied by Motokawa and Ebe, who point out that the fusion which occurs in apparent movement may take place at the retina through retinal induction.[5] They maintain, however, that not all aspects of apparent movement can be explained in purely peripheral terms. For instance, apparent movement occurs even if successive stimulations are presented to alternate retinas, a phenomenon which precludes a purely retinal explanation.

Gengerelli has noted another relationship between apparent movement and the central nervous system.[6] He has shown that apparent movement is obtained more readily between retinal stimulations which are represented on the same hemisphere (homonymous) than between stimulations which are represented on contralateral hemispheres (heteronymous). When both homonymous and heteronymous cerebral excitations are represented simultaneously, that movement predominates which has its base in the homonymous cerebral excitation.

Other investigators maintain that physiological processes cannot entirely explain apparent movement. Smith, in fact, has advanced the hypothesis that apparent movement is possible even in the absence of neural interaction.[7] He analyzed the neural tracts involved in apparent movement produced by alternating stimuli to nasal retinas, and concluded that, in all probability, no neural interaction corresponding to horizontal movement was involved. Smith states that the ". . . Gestalt theory of apparent movement, which contends that corresponding interaction is responsible for the perception of visual apparent movement, is thus cast into considerable doubt."

It does appear that there are certain aspects of the phenomenon that do not lend themselves to physiological explanations. For instance, apparent movement is more easily induced when the image is meaningful,[8] and is influenced by auditory and kinesthetic impulses.[4] Likewise, Benussi[9] (as cited by Boring[10]) reported that the path of apparent movement may bend around visual obstructions in the field rather than follow the shortest course.

From evidence such as this De Silva[8] concludes that ". . . even the univocality or discreteness of the perception of movement seems to be a relative affair, depending not only upon determinants in the stimulus, but also depending to a considerable extent upon vague 'natural' or 'artificial' attitudinal variables which call for further study."

Such a study was indeed made by Neuhaus[11] (cited by Neff[3]), who showed that psychological factors such as intent, attention, set, instruction and training all

affect the perception of apparent movement.

Helmholtz offered another nonphysiological explanation of apparent movement in terms of associationism. He believed that when the "same" image is successively perceived in close relationship, a long history of learning leads to an "unconscious inference" of movement.[4]

The welter of evidence for and against both physiological and psychological theories of apparent movement has induced most investigators to accept an eclectic position. Higginson[12] concludes that ". . . the visual apprehension of movement under discrete retinal stimulation is a form of abstractive perception determined by stimulus, receptor and central organs, the degree of abstraction depending on the availability of experiential items, and upon the relative contributions of environmental and of organic factors."

### Characteristics of Apparent Movement

Because there exists no universally accepted theory of apparent movement, it is necessary to describe this phenomenon on the empirical level, yet even in this sphere there is not complete agreement among investigators. Nevertheless, those characteristics of apparent movement which enjoy a fair consensus of agreement will be described.

Several types of apparent movement are possible. Graham[13] lists the alpha, beta and gamma types of movement as given by Kenkel[14] and the delta movement suggested by Korte.[15] Alpha movement involves the apparent change in size of the image under certain conditions of successive presentation. Beta movement is apparent lateral movement of the image when two points on the retina are illuminated equally and successively; this is the type of movement which occurs in motion pictures. Gamma movement occurs upon simultaneous presentation of a differentially illuminated image, in which case the apparent movement is from the brighter area to the dimmer; this phenomenon, according to Bartley,[16] is to be expected because of the shorter latency of the neural impulse arising from the more intense area. Gamma movement also pertains to the apparent expansion or contraction of an image as illumination is increased or decreased, and may be due, at least in some cases, to an increase or decrease in diffraction-pattern intensities.[13] Delta movement, like beta movement, is apparent lateral movement due to the presentation of two successive stimuli. However, beta movement is from the first to the second stimulus, while delta movement occurs in the reverse direction. Special conditions must obtain before delta movement can occur, one such condition requiring that the second stimulus be greater in intensity than the first stimulus, leading to the suspicion that this phenomenon may be due to the difference in latencies between the neural impulses.

Since motion pictures involve beta movement, it may be desirable to elaborate somewhat on this particular type of apparent movement. Beta movement actually subsumes two types of apparent movement: stroboscopic and phi. The apparent movement resulting from motion pictures is stroboscopic movement, not phi movement.

Phi movement (or pure phi) was first reported by Wertheimer[17] (as cited by Osgood[4]), who described the phenomenon as apparent movement in which (1) the form of the image is not perceived during movement, (2) the movement is singularly rapid and (3) the image is simultaneously perceived at its two terminal positions. Wertheimer assumed that phi movement could be induced only if the duration between stimuli was in the 60–200 msec range. However, such an assumption does not stand experimental test when factors other than the dark period are taken into account, factors such as the distance moved by the image between successive presentations, the exposure time and the exposure intensity.[2,13,18] All experimenters seem to agree, however, that phi movement occurs only under restricted conditions, conditions which do not prevail in motion pictures.

The relationships between several stimulus factors and apparent movement were first worked out by Korte and are known as Korte's Laws.[15] More recent investigators find these "laws" premature and inadequate.[2,11] One of Korte's Laws, for instance, states that as the stimulus intensity is increased, the spatial distance between the stimuli should also be increased in order to prevent the appearance of discrete movement. However, Korte used only a limited range of intensities, and Neuhaus discovered that Korte's dogma is far from true for all intensities.

After reviewing the empirical knowledge about apparent movement, Neff lists some twenty factors known to be related to this phenomenon, and most of these factors seem to be related to one another. Neff concludes that it is too early to formulate laws of the type attempted by Korte. More economical progress will probably be made by the accumulation of additional empirical data from limited investigations. Similarly, Graham states that the field of apparent movement "has suffered from too much generalization and too little experimentation and analysis."

### Control of Visual Angle

Visual angle was defined as the angle formed at the spectator by the displacement of the screen image between two successive frames. Other factors being equal, the perception of discrete movement becomes more probable as visual angle is increased. However, other factors never are equal in practice, and the relation between discrete movement and visual angle is not likely to be simple. Nevertheless, visual angle may prove useful in studies of apparent movement in motion pictures, so it seems worth while to describe visual angle as a function of film parameters.

It can be shown that

$$\theta = \frac{\omega\phi f w}{2\pi s a d}, \qquad (1)$$

where

$\theta$ = visual angle,
$\omega$ = relative angular velocity normal to the camera-object line,
$\phi$ = camera shutter angle,
$f$ = focal length of camera lens,
$w$ = width of screen (effective),
$s$ = speed of camera (frames/sec),
$a$ = aperture width of camera, and
$d$ = distance between spectator and screen.

If $f$ and $a$, and $w$ and $d$, are measured in the same units, then $\theta$ is given in radians if $\phi$ is measured in radians and if $\omega$ is measured in radians per second. If degrees are used instead of radians, the $2\pi$ should be changed to 360.

Visual angle is directly proportional to $\omega$, a measure of the displacement of the image falling on successive camera frames. This displacement results from movement of the object being filmed, lateral movement or rotation of the camera, or by any combination of these. Since $\omega$ is awkward to measure, it is more conveniently specified in terms of standard film parameters. Assuming a constant frame-by-frame horizontal displacement of the image across the camera film, we have

$$\omega = \frac{sa}{nf}, \qquad (2)$$

where $n$ represents the number of frames necessary for the image to completely traverse the horizontal dimension of the camera aperture. Substituting this expression into Eq. (1) gives

$$\theta = \frac{\phi w}{2\pi n d}. \qquad (3)$$

Equation (3) brings into focus the parameters associated with visual angle. This equation indicates that four steps may be taken to reduce visual angle: (a) decrease the camera shutter angle (increase shutter opening), (b) increase the number of frames over which the action occurs, (c) decrease the effective width of the screen or (d) increase the distance between spectator and screen. The first two factors involve filming parameters, the last two theater parameters. Practical considerations suggest that visual angle may best be controlled at the time of filming. In practice, $n$ may be increased by slowing down action which is parallel to the film plane or by increasing the angle between the direction of action and the film plane.

Although control of the filming situation affords the most practical method of minimizing discrete movement, another

possibility involves an increase in the projection interruption rate (normally three times the projection pulldown rate). Although this possibility has been little explored, it may afford a more adequate solution.

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**ABRIDGMENT**

# Safety Factors in Camera Exposures

By C. N. NELSON

**A new American Standard for determining the speeds of black-and-white negative films for still cameras was issued in April 1960 by the American Standards Association. The new speeds are approximately twice the exposure indexes defined by the older version of the Standard. The level of the numbers was increased in order to reduce the "safety factor" in camera exposures indicated by exposure meters. The reduced exposures give negatives that are better from the standpoint of ease of printing, sharpness, and print graininess. The present paper is a report on a study, made in connection with this standardization project, to determine the absolute magnitude of the safety factor. Both the mathematical and experimental parts of this study indicate that the safety factor associated with the exposure index is approximately 2.4 for average sunlit scenes when accurate meters, shutters and lens apertures are used. The safety factor associated with the new ASA speed is slightly more than 1.2, the same as for color reversal films. The revised speed criterion and the new *additive* system of units for film speed, scene light, lens aperture and shutter speed are described.**

During the past three or four years, much criticism has been aimed at the safety factor involved in the use of American Standard exposure indexes[1] with exposure meters calibrated in accordance with American Standard procedures.[2] A number of articles in photographic magazines have pointed out the penalties and disadvantages resulting from the use of too large a safety factor and have urged that a smaller safety factor be introduced by means of a revision in the American Standard for determining ASA exposure indexes for black-and white negative films. The general spirit of these articles is illustrated by the title of one of them: "ASA Exposure Index: Dangerously Safe."[3]

A safety factor exists in a camera exposure whenever that exposure is greater than the minimum camera exposure that will produce a negative from which a print of excellent quality can be made. The ratio of the actual camera exposure to this minimum camera exposure is, by definition, the safety factor.

If a large safety factor is used, the negatives obtained will, on the average, be much denser than is required for making a high-quality print. A small safety factor means thinner negatives. In the field of still photography, the main advantages of negatives resulting from the use of a small safety factor are:

1. easier focusing of enlargers;
2. shorter printing times;
3. less graininess in enlargements;
4. sharper pictures:
   a. greater depth of field;
   b. subject-motion blur reduced,
   c. camera-motion blur reduced.

Another advantage, which occurs with some films (especially if they have been overdeveloped), is that the shape of the part of the density-vs.-log exposure curve used for the thinner negatives is better than the shape of the part of the curve used for the heavily exposed negatives.

Because of these advantages, many photographers are convinced that the best camera exposure is one which is only slightly greater than the minimum camera exposure required for a print of high quality.

The main disadvantage of a small safety factor is, of course, that occasionally an underexposed negative will be obtained as a result of an error in camera exposure. The original purpose of the safety factor was to absorb such errors. Present-day experience with color reversal films for which a large safety factor cannot be used shows, however, that the number of underexposed pictures resulting from the use of a small safety factor is remarkably small.

If a large safety factor is undesirable at the present time, why was a substantial safety factor thought to be necessary when the American Standards for film ratings and exposure meters were first adopted in the 1940's? The first reason is that exposure meters, camera shutters and lens apertures were not as accurate in 1940 as they are in 1960. The second reason is that the camera-exposure latitude was effectively greater in those earlier years, largely because the increase in print graininess with increase in camera exposure was not so evident with the large cameras, large negatives, and the small degree of enlargement or contact printing then commonly used. The great increase in the number of small cameras in use in recent years and the increase in the degree of enlargement has made the graininess problem more significant.

Many photographers have adopted the practice of giving less exposure than is indicated by the use of ASA exposure in-

An abridgment of Communication No. 2061 from the Kodak Research Laboratories, Rochester, N. Y., which was published in *Phot. Sci. Eng., 4, No. 1:* 48–58, Jan.-Feb., 1960. Some additions to the text have been made in recognition of the publication, in Apr. 1960, of the new American Standard on photographic speed.

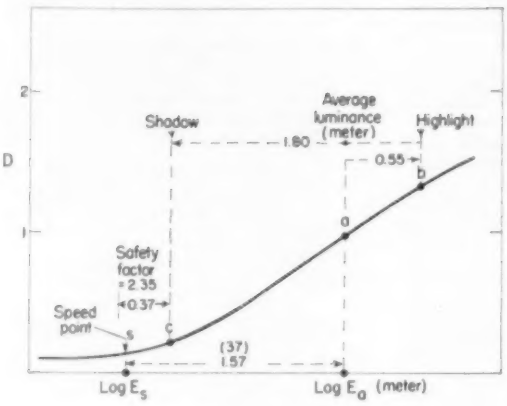


**Fig. 3. Predicted location, on the D-log E curve, of the negative of an average sunlit scene exposed in accordance with the ASA exposure index used with a calibrated exposure meter.**

dexes with exposure meters. They use the American Standard indexes only as a starting point for deriving a new kind of exposure index which is obtained by the simple procedure of doubling the Standard exposure index. This practice, of course, has the effect of cutting the safety factor in half, giving the preferred thinner negatives.

In recognition of this practice, the American Standards Association formed a new subcommittee, under the chairmanship of J. L. Tupper, for the purpose of revising the American Standard on speed and exposure index. In April 1960, the revised Standard[4] was published, having been approved by the ASA Sectional Committee on Photographic Sensitometry (M. G. Anderson, Chairman), the Photographic Standards Board, and the officials of the ASA. Copies of the Standard can be purchased from the American Standards Association.

In the new Standard, the term "speed" replaces the term "exposure index." The new speeds are approximately twice the exposure indexes. This change reduces the safety factor to one-half its former value for the black-and-white materials covered by the Standard. Color films are not affected.

The magnitude of the safety factor associated with the exposure index of black-and-white films has usually been assumed to be somewhere between 2 and 4. The most common estimate has been 2.5. A few writers have contended that it is 4. It is a remarkable fact that the exact size of the safety factor has not been definitely known. It is not mentioned in either the Standard on exposure indexes or the Standard on calibration of exposure meters.

The purpose of the present paper is to present new evidence on the magnitude of the safety factor in the photography of average sunlit scenes. Two independent approaches were used, one theoretical and the other experimental.

This study was undertaken by the writer as a member of the ASA subcommittee on film speed, and as a member of the ASA subcommittee on exposure meters.

### Calculation of the Safety Factor

An estimate of the size of the safety factor can be obtained by means of calculations based on the following three formulas:

1. The camera image illumination formula[5]

$$I = CB/f^2 \qquad (1)$$

where

$I$ = image illuminance on the film in meter-candles;
$B$ = object luminance in candles per square foot;
$f$ = $f$-number setting of the lens, and
$C$ = a constant which is approximately equal to 7 if the assumptions are made that the lens transmittance is 0.95, the distance from the lens to the subject is forty times the focal length of the lens, and the subject is 12 degrees off the camera-lens axis ($\cos^4\theta = 0.91$). These assumptions are believed to be appropriate for an average camera with a coated lens used under average conditions of photography.

2. The American Standard formula for calibration of exposure meters[2]

$$t = 1.17f^2/BZ \qquad (2)$$

where

$t$ = exposure time;
$f$ = $f$-number of the lens;
$B$ = object luminance in candles per square foot, and
$Z$ = American Standard exposure index of the film.

3. The American Standard formula for the film exposure index[1]

$$Z = 4E_s \qquad (3)$$

where

$Z$ = American Standard exposure index, and
$E_s$ = the exposure in meter-candle-seconds required to obtain a specified minimum response on the film as determined by the fractional-gradient speed criterion.

In the use of these formulas to compute the safety factor, it is assumed that a photograph is to be taken of an average sunlit scene and that the camera settings of exposure time and $f$-number are to be determined by a calibrated exposure meter which is used to measure the "average luminance" of the scene. It is also assumed that a spectrally nonselective gray object is placed in the scene having a reflectance and an orientation such that its luminance is equal to the "average luminance" of the scene. The exposure, $E_a$, on the film in the camera in the image of the gray object is equal to $I_a t$. Then, from Formula (1), $E_a = CB_a t/f^2$. Combining this expression with Formulas (2) and (3) and inserting certain corrections due to flare light and the ultraviolet content of the radiation used in determining the exposure index, as described in the original paper of which this is an abridgment, it is found that

$$E_a/E_s = 37 \qquad (4)$$

where $E_a$ is the exposure on the film for the gray object representing the "average luminance" of the scene, and $E_s$ is the "minimum useful exposure" defined by the fractional-gradient speed criterion specified in the former American Standard, PH2.5-1954.

Figure 3* shows where $E_a$ falls on the $D$-log $E$ curve of the film. $E_a$, the exposure for the gray object read by the meter, lies a certain interval to the right of the speed point. According to the calculations, this interval is 37 times greater than $E_s$, or 1.57 in logarithmic units.

The safety factor can now be derived from this interval by making use of the scene luminance measurements published by Jones and Condit.[5] They found that for 126 outdoor scenes, the maximum luminance or "highlight" was on the average 0.55, in log unit, greater than the average luminance. This result is used in Fig. 3 to locate the highlight point, $b$, on the curve 0.55 unit to the right of point $a$. Jones and Condit also found that for average outdoor sunlit scenes and an average camera, the minimum luminance or deepest shadow in the scene is recorded 1.8 in log $E$ units to the left of the highlight point, as shown in Fig. 3. It is seen that the shadow is recorded a certain log $E$ interval to the right of the speed point. This interval would be equal to the logarithm of the safety factor if the flare light in the camera were equal to that which is typical of an average uncoated lens and an average scene. When camera flare is equal to that which is typical of an average coated lens and an average scene, the deepest shadow can be placed about 0.05 to the left of the speed point

* Figures 1, 2, 4, 6, 8, 10, 12 and 13 of the original article are omitted.

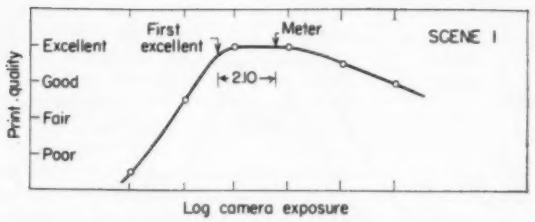


**Fig. 5. Curve showing print quality vs. log camera exposure for Scene 1, obtained by the experimental method. The number under the curve is the safety factor.**

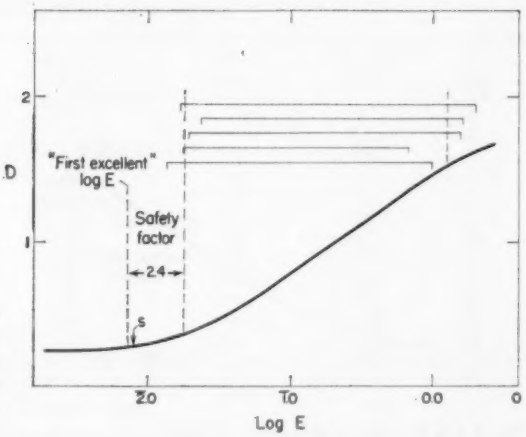


**Fig. 7. Log E positions of the negatives of the five scenes exposed as prescribed by a calibrated exposure meter used with the ASA exposure index of the film.**

because a lower slope on the curve is usable when the shadow contrast in the camera image is increased by the reduction in camera flare.

Consequently, the minimum negative exposure that will result in a print of high quality is considered to lie about 0.05 to the left of the fractional-gradient speed point. The total log $E$ interval in Fig. 3 between the shadow point $c$ and the minimum exposure that will give an excellent print is, therefore, 0.37. This interval is equal to the logarithm of the safety factor. These calculations, therefore, lead to the conclusion that the safety factor associated with the ASA exposure index is 2.35.

### Experimental Determination of the Safety Factor

In the experimental approach to the estimation of the safety factor, five outdoor sunlit scenes, each containing a person, were photographed on Kodak Panatomic-X Film with a series of six different camera exposures for each scene, using an accurately calibrated camera. The interval between successive exposures was a factor of 2. Exposure-meter readings were made on each scene using the "reflected light" ("average luminance") method. Three different exposure meters, each made by a different manufacturer and each accurately calibrated, were employed.

The negatives were developed for 8 min at 68 F in Kodak Developer D-76. In the same process were included sensitometric samples of the same film exposed on an intensity-scale sensitometer. The negatives were projection-printed on Kodak Medalist Paper using the best grade of paper and the best printing exposure for each negative. The degree of enlargement was 5 diameters.

The prints were judged by ten observers who expressed their estimation of the quality of each print by means of the terms: Excellent, Good, Fair, Poor, and Very Poor. These judgments took into account not only the tone-reproduction characteristics of the print but also the other factors that affect quality, such as graininess, sharpness, depth of field and camera motion.

Figure 5 shows the print-quality ratings for Scene 1 plotted against the camera exposures. The exposures are expressed on a logarithmic scale, the interval between the small vertical marks being 0.3. The camera exposure required to obtain the "first-excellent print" was obtained by taking the first point on the curve at which the quality reached a value of 95% of the maximum quality. To the right of the first excellent point is a point marked "meter" which shows the camera exposure prescribed by the exposure meter. The ratio of the camera exposure indicated by the meter to the camera exposure required for the first excellent print is the safety factor. The results for all five scenes are:

| *Scene* | *Safety Factor* |
|---|---|
| 1 | 2.10 |
| 2 | 2.24 |
| 3 | 2.62 |
| 4 | 2.45 |
| 5 | 2.62 |
| Average . . . . | 2.41 |
| (Standard deviation = 0.2) | |

This average safety factor of 2.4 is in close agreement with the value of 2.35 obtained by the calculations described in the preceding section. It also agrees very well with the value of 2.5 which has generally been assumed.

These results apply when the camera settings of aperture and time are accurate and the exposure-meter calibration is precisely that specified in the American Standard for exposure meters. In practice, most between-the-lens shutters give exposure times that are greater than the marked values when small apertures are used. Camera shutters are generally calibrated at maximum lens aperture where the efficiency of the shutter is at its lowest value. When the lens opening is reduced, the efficiency of the shutter increases and the effective time becomes longer. Furthermore, some exposure meters have calibration constants that lead to greater exposure. The net result is that the effective safety factor is, in practice, often greater than 2.4.

### Negative Exposure Levels and Negative Densities

Figure 7 shows the log $E$ positions for the five negatives having the camera exposures indicated by the calibrated exposure meters used with the ASA exposure index of the film. The negatives were located with respect to the $D$-log $E$ curve by means of measurements of the maximum and minimum densities in each negative. Interpolation between negatives in the exposure series was, of course, necessary. The negatives prescribed by the meter are seen to have greater density than is generally preferred. The diffuse white objects in the scene are recorded 2.35 logarithmic units and the face areas 1.9 units to the right of the fractional gradient speed point. The extreme-shadow areas lie 0.34 unit to the right of the speed point, and 0.38 unit to the right of the log $E$ position of the shadow areas of the negatives that gave the first excellent prints. The safety factor, as shown, is 2.4 in arithmetic units.

Figure 9 shows the log $E$ position for the negative of an average scene when the camera exposure is that indicated by a calibrated exposure meter used with the new ASA speed of the film. The safety factor is 1.2. The light tones of the face are recorded at an exposure which is about 40 times, or 1.6 in logarithmic units, greater than the exposure at the fractional gradient speed point, $S$. Diffuse white objects in the scene are recorded 2.05 logarithmic units to the right of the speed point. The shadows fall 0.05 to the right of the speed point, but are 0.09 to the right of the first excellent point (shown on the preceding graph). This level of exposure is preferred for most practical work.

### Color Reversal Films

Color films do not fall within the scope of the new American Standard on speed, PH2.5-1960, or the former American Standard on exposure index. Exposure indexes for color films are ordinarily assigned by means of practical camera tests. An American Standard method for determining the speed of color reversal films is in preparation, however, and

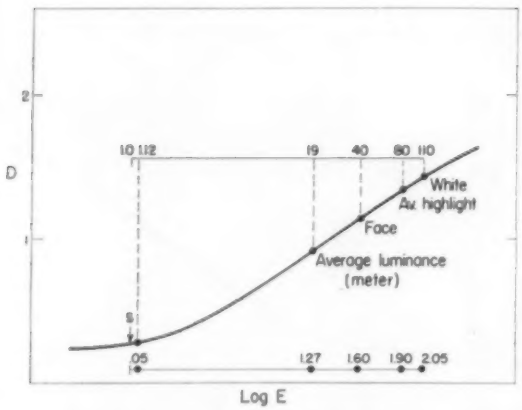


**Fig. 9. Log E positions of the various scene elements recorded in a negative exposed as prescribed by a calibrated exposure meter used with the new ASA speed of the film.**

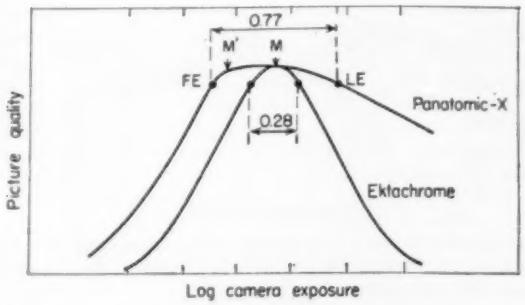


**Fig. 11. Picture-quality vs. log-camera-exposure curve for a black-and-white film compared with the corresponding curve for a color reversal film having the same exposure index. FE represents "first excellent"; LE, "last excellent." M is the recommended exposure level for the color film. M′ is the new exposure level recommended for the black-and-white film.**

may be released soon. The safety factor involved in the exposure index of a color reversal film is generally small because of the limited camera-exposure latitude of the film. The exposure indexes of this type of film are chosen so that when the numbers are used with exposure meters, the resulting transparencies will have a quality equal to the best that can be obtained by varying the camera exposure (Fig. 11). Decreasing or increasing the exposure by approximately one-third of a camera stop gives a slight but noticeable loss in quality. The slight loss is approximately equal to that used in defining the first excellent level of camera exposure for black-and-white negative films. Thus, on this comparable basis, the safety factor associated with the exposure indexes of color reversal films is approximately the same as that associated with the new ASA speeds of black-and-white negative films (slightly over 1.2).

Exposure indexes, by incorporating a relatively large safety factor (2.4) for black-and-white films and a small safety factor (1.2+) for color reversal films, did not reveal the fact that the basic speed of the black-and-white film was approximately twice that of a color reversal film assigned the same exposure index.

The latest film ratings eliminate this discrepancy and indicate the true speed relationship between these two types of film.

### Change in the Speed Criterion

The reduction in the safety factor could have been accomplished simply by changing the constant in the ASA formula for deriving the ASA exposure index from the ASA fractional-gradient speed of the film. There are several reasons, however, for adopting not only a new constant but also a different speed criterion. The fractional-gradient criterion was originally chosen because it has the desirable feature of giving speeds that correlate closely with speeds obtained by practical picture tests. It has the objectionable feature, however, of being somewhat inconvenient and difficult to use. Consequently, a simpler and more convenient criterion, such as that based on a fixed density above fog and base density, is often desired. Fortunately, as shown by the recent data of Nelson and Simonds,[6] a good correlation exists between fractional-gradient speeds and speeds based on a density of 0.1 above fog, *provided the development conditions are controlled so that a fixed "average gradient" is obtained.* This average gradient is measured on the portion of the *D*-log *E* curve of the film lying between two exposures, *E* and 20*E*, where *E* is the exposure at a density of 0.1 above fog.

The new American Standard speed is defined as follows:

$$\text{Speed} = 0.8/E_m \qquad (5)$$

where $E_m$ is the exposure in meter-candle-seconds required to obtain a density of 0.1 above fog when the development is such that the average gradient, as defined above, is 0.62.

The specification of a fixed average gradient corresponds to the common photographic practice of developing negatives so that they print satisfactorily on a "normal" grade of photographic paper. Thus, the adoption of the 0.1 fixed-density speed criterion in combination with this development specification gives the advantages of practical significance and ease of measurement.

Another important advantage gained by adopting the fixed-density speed criterion as part of an American Standard is that this step is likely to encourage eventual agreement on an international standard for photographic speed. The fixed-density criterion has for many years been a preferred criterion in a number of countries. The use of this criterion in the DIN system, for example, is particularly well known.

The constant of 0.8 in the new formula for speed was chosen so that the desired safety factor of slightly more than 1.2 is obtained, on the average, when the speeds are used with accurate exposure meters and accurate cameras.

### The Additive System of Photographic Exposure

A remarkably simple system of *additive* units[4,7] for film speed, scene light, lens aperture and shutter speed is offered by the revised American Standard on photographic speed and the forthcoming revised Standard on exposure meters. The scale used for each of these variables is a series of small numbers: 0, 1, 2, 3, 4, 5, -6, 7, 8, 9, 10, 11. Each step on this scale represents a factor-of-2 change in the variable.

The system is known as the *A*dditive System of *P*hotographic *EX*posure (APEX). The calculation of the camera settings required for any film-and-scene combination can be done by simple, mental arithmetic. The rule is as follows: The film "speed value" ($S_v$) is added to the "light value" ($B_v$) and the sum is noted. An "aperture value" ($A_v$) and a "shutter value" ($T_v$) are then chosen which have the same sum. This rule is expressed by the equation:

$$S_v + B_v = A_v + T_v$$

The APEX values are additive because the numbers are logarithms (base 2). The sum of $A_v$ and $T_v$ is the "exposure value" ($E_v$) which has appeared on a number of cameras and exposure meters in recent years.

The relation between the new and the old units is shown in Table I.

The new "speed value" is written with a degree sign, for example, ASA 5°, to distinguish it from the "speed" which, for example, is written, ASA 100 or ASA 5. Intermediate values, such as 5½, 6½ and 7½, are used for any of the APEX variables when finer steps (square root of 2) are desired.

The ease with which the additive system can be used in practice is illustrated by the following example: The light value of an average sunlit scene is approximately 10. If the speed value of the film is 4°, the sum of the two numbers is 14. Aperture and shutter values are, therefore, chosen which have a sum equal to 14, with the restriction that if the camera is hand-held, the shutter value should be not less than 6 (equivalent to 1/60 sec) in order to "stop" camera motion and subject motion adequately. Thus, if a shutter value of 7 is selected, an aperture value of 7 must be chosen in order to balance the equation and obtain the proper exposure. The arithmetic of the operation is

$$10 + 4 = 7 + 7.$$

In the old system, the calculation of the *f*-number required for the proper exposure is based on the formula,

$$t/f^2 = 1.17/BS_x$$

where $t$ is the exposure time, $B$ is the average luminance of the scene in candles per square foot, and $S_x$ is the ASA speed of the film. Solving the equation for $f$ involves multiplying, dividing, and extracting a square root. Because of the inconvenience of this task, it is usually done by means of the computer on an exposure meter or exposure guide.

The advantage of the APEX system will be most apparent to beginners in photography, who often have difficulty understanding the intricacies of *f*-numbers. Experienced photographers will recognize that the new system makes use of one of their valuable aids: the rule that the *f*-number series, *f*/2.8 *f*/4, *f*/5.6, *f*/8, *f*/11 and *f*/16, represents factor-of-2- steps in exposure.

**Table I. Relations Between the New and Old Units.**

| APEX value | Film speed | Reflected light* | Incident light† | Shutter time | *f*-No. |
|---|---|---|---|---|---|
| 0 | 3 | 0.3 | 6 | 1 | 1 |
| 1 | 6 | 0.6 | 12 | 1/2 | 1.4 |
| 2 | 12 | 1.2 | 25 | 1/4 | 2 |
| 3 | 25 | 2.5 | 50 | 1/8 | 2.8 |
| 4 | 50 | 5 | 100 | 1/15 | 4 |
| 5 | 100 | 10 | 200 | 1/30 | 5.6 |
| 6 | 200 | 20 | 400 | 1/60 | 8 |
| 7 | 400 | 40 | 800 | 1/125 | 11 |
| 8 | 800 | 80 | 1600 | 1/250 | 16 |
| 9 | 1600 | 160 | 3200 | 1/500 | 22 |
| 10 | 3200 | 320 | 6400 | 1/1000 | 32 |
| 11 | 6400 | 640 | 12500 | 1/2000 | 45 |

* Candles per square foot.
† Foot-candles on a vertical plane facing the camera.

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**REPRINT**

# An Image Intensifier With Transmitted Secondary Electron Multiplication*


By W. L. WILCOCK, D. L. EMBERSON and B. WEEKLEY


THE USE OF transmitted secondary electron emission for electron multiplication has been proposed by Lubszynski,[1] McGee[2] and Sternglass,[3] and photoemissive image intensifiers incorporating thin films of potassium chloride as transmitted secondary emitters have been described by Wachtel, Doughty and Anderson.[4] We also have been experimenting with the construction of image intensifiers of this kind.

The form of the tubes we have made is shown in Fig. 1. They consist essentially of an antimony-caesium photocathode, an aluminium-backed zinc sulphide-silver phosphor, and between these a set of parallel electron-multiplying dynodes which are layers of aluminium and potassium chloride deposited on a supporting film of aluminium oxide. Electrons from the photocathode are accelerated and focused on the first dynode by means of coaxial electric and magnetic fields, and secondary electrons are produced which escape from the dynode on the side remote from the photocathode. These transmitted secondaries are similarly accelerated and focused on the second dynode, where further transmitted secondary electrons are produced; and this process is repeated down the tube. Finally, the electrons which emerge from the last dynode are accelerated and focused on the phosphor.

The electric field is provided by cylindrical electrodes on the inner wall of the tube, which are connected to an external potential divider. The magnetic field is provided by a long solenoid which surrounds the tube. In order to prepare the photocathode without admitting caesium to the working section of the tube we have made use of the arrangement described by McGee.[5] At a short distance from the front window of the tube there is an annular metal shelf which fits the inside of the tube closely enough to act as a barrier to caesium vapour, and a glass plate is held to this shelf by means of a spring catch which can be released by tapping the outside of the tube. The photocathode is formed on the surface of the plate which faces the front window of the tube. After the tube is sealed off from the pumps, the plate is released and turned over so that the photocathode faces the dynode system.


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* A more extensive account of this work is given in "Work at Imperial College on Image Intensifiers With Transmitted Secondary Electron Multiplication," W. L. Wilcock, D. L. Emberson and B. Weekley, *Trans. IRE* (*Nuclear Science*), to be published in the near future.

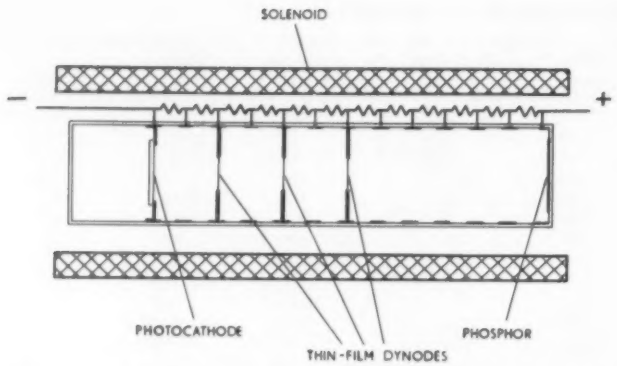


**Fig. 1. Image intensifier with transmitted secondary electron multiplication.**

The tube we have prepared most recently has five 1-cm diameter dynodes, each consisting of a layer of aluminium ~200 A thick and a layer of potassium chloride ~500 A thick deposited on a film of aluminium oxide ~450 A thick. The sensitivity of the photocathode is 20 μamp/lumen. We have operated this tube with 37 kv between photocathode and phosphor. The potential difference between the cathode and the first dynode, and between successive dynodes, is then about 4.9 kv, and the magnetic field required for focus is 180 gauss. Under these conditions the total electron multiplication is $\sim 3.5 \times 10^3$, and the ratio of total light output to light input is $\sim 8 \times 10^4$ when the incident light is of the same mean wavelength as the phosphor emission. The sensitivity of the photocathode corresponds to a quantum efficiency of about 4% at this wavelength, so that each electron leaving the cathode must result on average in a pulse of about $2 \times 10^6$ photons from the phosphor. These pulses are easily visible with a low-power microscope as bright scintillations on the phosphor, with diameters of about 40 μ. For an average scintillation the photon density at the phosphor thus exceeds $10^{11}$ photons $cm^{-2}$, and since a photon density of $10^9$ photons $cm^{-2}$ is sufficient to give a detectable image on a very fast photographic emulsion,[6] it is to be expected that the scintillations can be photographed with relatively inefficient optical coupling between the phosphor and the emulsion.

We have been able to take such photographs (Fig. 2) on Kodak Tri-X film, using a pair of 50mm $f/2$ lenses front-to front to give unity magnification. The exposure time for each photograph was 0.5 sec. Figure 2a was taken with the tube in the dark at room temperature, and shows the scintillations due to dark emission from the photocathode. The rate of background scintillation is $\sim 6 \times 10^3$ $cm^{-2}$ $sec^{-1}$. The corresponding cathode dark current, if each electron emitted gives rise to a scintillation, is $\sim 10^{-15}$ amp $cm^{-2}$, which is a reasonable value for an antimony-caesium cathode. For Figs. 2b, c, d and e, the image of a resolution test object was projected on to the photocathode with successively increased levels of illumination. The test object was a fan of 15 black-and-white line-pairs. In Fig. 2b the illumination is so low that the photoemission is only of the same order as the dark emission, and the object is detectable only as a local increase in the scintillation density. Increases in illumination lead to the object becoming barely recognizable (Fig. 2c), and clearly so (Figs. 2d, e). The limiting resolution is about 15 line-pairs/mm, and is determined largely by the diameters of the scintillations.

We are grateful to Prof. J. D. McGee for his interest and encouragement, and to the Department of Scientific and Industrial Research for financial support.

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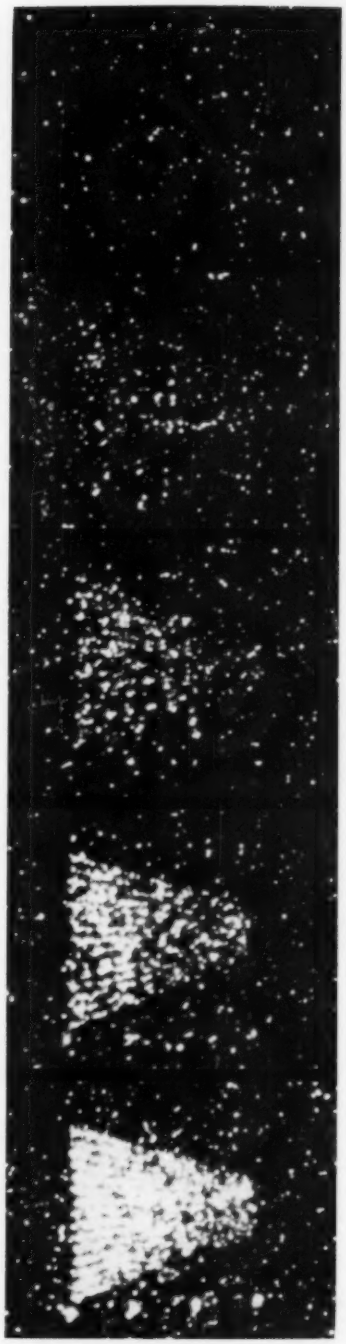



**Fig. 2. Photographs obtained with image intensifier showing scintillations resulting from single electrons leaving the photocathode: a, dark background; b, c, d, e, image of fan-shaped test object projected on photocathode with successively increased levels of illumination. Exposure time 0.5 sec.**

# Rapid-Starting High-Speed Cameras

By W. O. S. JOHNSON

**Two rapid-starting high-speed cameras have been designed to record rapid phenomena occurring at random. The novel film-transport system employed in these cameras, as well as associated triggering, timing and lighting equipment, is discussed.**

Two high-speed motion-picture cameras have been developed which have several unique features. One feature is the ability to operate at full speed within a few milliseconds after a starting signal, in contrast to the more commonly used high-speed cameras which require several tenths of a second to accelerate to full speed. This feature makes it possible for the first time photographically to record rapid events occurring at random. Another feature is the ability to take any number of runs, ranging in length from 1 to 40 ft, on a single roll of film.

The two cameras are basically similar but were designed for widely different purposes. The first was built for use in studying the flight of birds. It uses 16mm film, and since the range of intended subject matter is relatively limited, it operates at four fixed speeds of 200, 400, 800 and 1600 frames/sec. The second is a 35mm camera, intended for industrial purposes and to operate over a wide speed range. Both cameras were designed and fabricated by L. C. Eichner Instruments, Clifton, N. J.

The rapid starting of these cameras is accomplished by an unorthodox film-transport mechanism, consisting of a pair of constantly rotating rolls which, on signal, are brought together, gripping the film between them, wringer-fashion, and accelerating it rapidly to the peripheral velocity of the rolls. A unique film supply configuration limits the length of film which must be accelerated at any instant to a few inches.

### Original Rapid-Starting Camera

The film-transport system described above was developed by L. J. Hooper at the Alden Hydrodynamics Laboratory of Worcester Polytechnic Institute. His camera is part of the Alden Laboratory's research equipment. With it, a series of stroboscopic images are taken in turn along a length of 70mm film, the intervals between pictures being established by a time-base generator. A piece of film of the correct length for a single run is darkroom-loaded into a separable supply chamber, the film being manually arranged in rather regular loops or festoons. The supply chamber is clamped into place, and the leading end of the film is fed through the camera past the optical gate, between the rollers and into a removable, light-tight receiver. A solenoid is energized, bringing the two rotating rollers together onto the film which is thus drawn out of the upper chamber, past the camera lens, between the rollers and into the receiver. During the passage of the film through the camera, the field of view (of the camera) is illuminated by stroboscopic pulses of light, the repetition rate of which is controlled by a time-base generator, thus exposing selected areas along the length of the film.

In Hooper's original camera, the image series is not registered with perforations in the film. In the cameras described here, however, the flashing of the stroboscopic lamp is synchronized with the passage of the film perforations through a photoelectric scanning system, thus providing precise registry of each frame. Both may be loaded in daylight and use standard ciné spooling.

### 16mm Camera

Figure 1 shows the 16mm camera. Inasmuch as this was essentially the prototype, it will be described here in some detail.

The camera consists of the same three major parts as Hooper's camera: a supply chamber; the camera proper which houses the driving rolls, lens and aperture; and the receiver into which film is "dumped" (Fig. 2). The supply chamber and receiver are not removable but are fitted with light-tight covers for cleaning, inspection and loading.

In loading the camera, film is led from the supply reel over a metering sprocket through the upper film-supply chamber, then through the film-chute and gate assembly, between the driving rolls and through the lower film chamber to the take-up spool (see Fig. 2). After fastening upper and lower film-chamber covers in place and drawing the first 4 ft of exposed film through the camera, the desired amount of film for an entire sequence is fed into the upper film chamber by manually rotating the metering sprocket; each revolution feeds in 6 in. of film. The film arranges itself in completely random fashion into a number of loops or festoons. The film-festoon chamber has a capacity of up to 30 ft of film, so that runs of up to 1200 frames can be made.

The motor-driven rollers are arranged so that, normally, a peripheral clearance of 0.008–0.010 in. exists. The larger roller is belt-driven from the constant-speed motor; a step-pulley arrangement provides speeds of 200, 400, 800 and 1600 frames/sec. The small, low-inertia roller is carried by Oilite* bushings on an eccentric shaft and is surface-driven by a pair of narrow rubber tires mounted on the edges of the larger roll, one on either side of the film. Energizing a rotary solenoid connected to the eccentric shaft causes the shaft to rotate clockwise through the small angle (5–10°) necessary to bring the two rolls tightly together onto the film. Because the film supply lies in loose loops or festoons, only the film in the film gate and the first half-loop of the film festoon are accelerated at any instant. As the rolls continue to draw film through the film chute, new areas of film are progressively accelerated until the supply in the upper chamber is almost depleted. It is necessary that the duration of each run be limited to ensure that film is never drawn

* Trademark of the Chrysler Corp.

**Fig. 1. 16mm rapid-start camera.**

Presented on October 9, 1959, at the Society's Convention in New York by W. O. S. Johnson, Mechanical Development Laboratory, E. I. du Pont de Nemours & Co., Wilmington, Del. (This paper was first received on October 8, 1959, and in final form on June 14, 1960.)

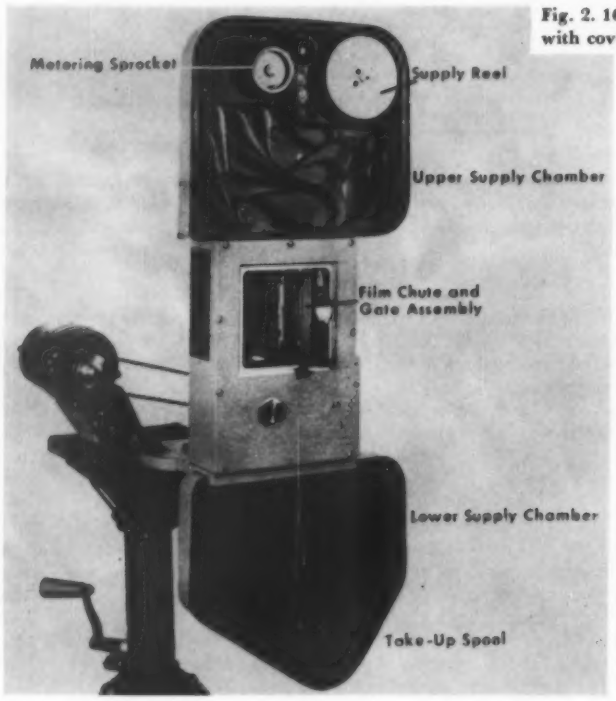



**Fig. 2. 16mm camera with covers removed.**

**Fig. 3. Control console for 16mm rapid-start camera.**

directly from the supply reel, as this will either tear the film or damage the camera, or both. Below the drive rolls, the film is dumped into the lower chamber, where it again arranges itself in random festoons. Following each run, this film is wound manually onto the take-up spool.

Between the upper film-festoon chamber and the drive rolls, the film-chute assembly guides the film in a path as precise as is consistent with its free, easy movement; this assembly also contains the optical gate of the camera. Directly below the optical axis of the camera is the photoelectric system which, by scanning the perforation area on one edge of the film, provides a synchronizing pulse to a high-speed stroboscopic lamp as each perforation passes. This synchronizing unit consists of a "grain-of-wheat" lamp, an optical system which focuses the reduced image of the lamp filament onto the film plane, and, on the far side of the film, a germanium phototransistor and one-stage transistor amplifier. Originally, a Dumont Type 6365 photomultiplier and two-stage vacuum-tube amplifier and shaping circuit were used, but the much simpler transistorized circuit has proved to be more rugged and reliable.

A through-the-lens focusing viewfinder is provided, which has a retractable prism assembly and an eyepiece shutter. With the eyepiece handle in the horizontal position, the optical image plane, magnified about four times, is seen as a ground-glass image. No attempt at image inversion was made, so that the field of view is seen upside down. Swinging the handle counterclockwise about 45° opens the the film gate by retracting the viewfinder prism assembly and places a shutter blade across the eyepiece to prevent the entry of stray light during operation of the camera.

The necessary timing and control circuits are housed in a separate control console (Fig. 3). An electromechanical timer is used to control the duration of each picture-taking cycle. As mentioned above, it is necessary that the cycle be precisely controlled so as to prevent film beyond that stored in the upper festoon chamber from being drawn through the camera by the rollers. Switches, each of which has an indicator lamp, provide power to the various camera functions. Since the camera is designed to be operated from a random signal, it was necessary to prevent a second signal from initiating a second sequence immediately following the first, thus tearing the film or causing other damage. This was accomplished by a one-shot circuit which drops out as the camera is energized and must be reset manually before the camera will again operate. The trip-ready switch resets this circuit and is customarily not operated until the supply of film in the upper festoon chamber has been replenished and all other operating parameters have been checked.

*Stroboscopic Lighting Equipment*

An Edgerton, Germeshausen & Grier, Inc., Type 501, high-speed stroboscope (Fig. 4) is used to provide the necessary subject-area lighting for the camera. It is designed to produce intense flashes of light with a flash duration of 1–3 μsec at rates up to 6000/sec. This unit consists of an electronic flashtube, a control or modulator unit and a power supply. Synchronizing pulses from the perforation-scanning pickup in the camera are fed to the unit, and this produces a single flash of illumination as each frame of film is registered precisely in the film gate. Three settings are provided to control the light output per flash. The flash discharge capacitance may be set at 0.01, 0.02 or 0.04 μf, with resultant flash energies of 0.32, 0.64 and 1.28 joules (watt-seconds), respectively. With the camera operating at 1600 frames/sec and a flash duration of 2.1 μsec, image smearing due to film motion is about 0.001 in.

The camera is usually operated at the highest power setting, 0.04 μf, so that with 1600 flashes/sec. at 1.28 joules/flash, the lamp has an average power input of about 2 kw. As this can be maintained without destruction of the lamp for about 0.8 sec, the camera can be operated at its full capacity of 30 ft of film (1200 frames) without damage to the lamp. The guide number under these operating conditions is 30 when using du Pont Type 931 film (guide number = lens *f*-stop × lamp-to-subject distance).

*Camera Performance Measurement*

The triggering of the camera has been mentioned earlier. As this camera was primarily developed to permit the study of the flight of free birds in their natural environment, several photoelectric trip circuits have been developed to signal the passage of birds into the field of view. It was necessary to determine with some precision the camera's response time, i.e., the number of milliseconds following the receipt of a triggering signal before the energizing of the solenoid brought the film into motion, as well as the uniformity of film acceleration and deceleration and the constancy of film velocity throughout a run. This was accomplished by using the camera as an oscillographic camera to photograph the screen of a dual-beam cathode-ray oscilloscope, on which only *X*-axis modulation is displayed; the motion of the film through

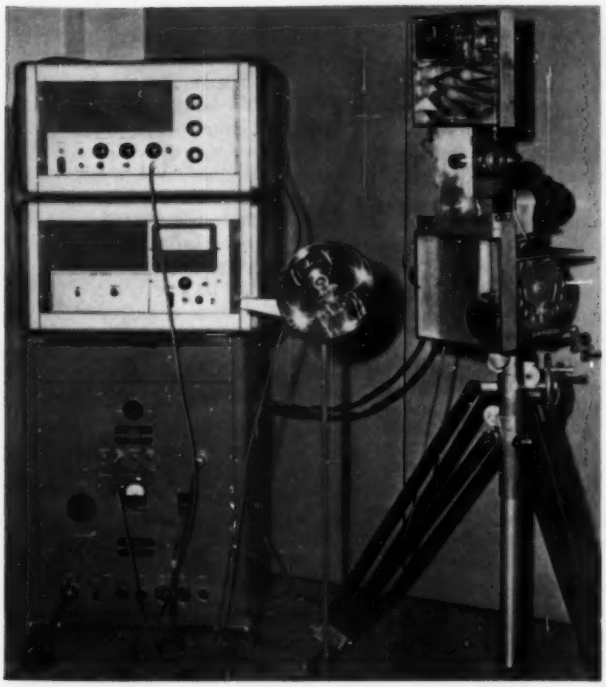


**Fig. 4. Complete 35mm rapid-start-camera assembly.**

**Fig. 5. The 35mm rapid-start camera with covers removed.**

the camera provides the vertical coordinate. By driving one *X*-axis amplifier from a 1000-cycle/sec sawtooth time generator, the film velocity and acceleration were determined by measuring the spacing of the image points along the film.

In order to determine the camera's overall response time, a predetermined counter was set up to count off the 1000-cycle/sec pulses, starting as the trigger signal was received and producing a marker pulse on the second oscilloscope trace coincident with the twenty-fifth count. By counting back from this tagged pulse on the film, the time required to move the first usable frame of film into place in the camera's gate was found to be between 2 and 3 msec. The decrease in velocity from beginning to end of a 20-ft length of film was about 10%. Acceleration of the film to the peripheral velocity of the drive rollers occurs within the first $\frac{1}{4}$ in. of film motion. The oscillographic method was also used to assess the performance of the strobe synchronizing circuit, the output waveform being photographed at the same position on each frame in turn. On projecting the film, any deviation of the waveform could be readily seen.

*Results*

The 16mm rapid-starting camera has been in use for two years: about 50,000 ft of film have been exposed in it. It was designed to use the series of lenses developed for the Arriflex camera, since a complete complement of these lenses was available. The field of coverage is limited by the capabilities of the stroboscopic lamp; under normal conditions a field of about 12 by 15 in. is used. The camera has been used successfully, however, in taking fields of view from less than $\frac{1}{2}$ sq in. to over 2 by 3 ft. The perforation-scanning system of frame registration has proved to be quite successful in that the vertical stability of the projected sequence of pictures is superior to that of normal 16mm motion pictures taken with any of the standard semiprofessional cameras.

**35mm Industrial Camera**

Following the successful field testing of the 16mm camera, it was decided that a camera capable of photographing rapid events occurring in random fashion would be a useful addition to the du Pont Company's high-speed photography equipment. Such a camera would permit the study of many events for which available cameras were not particularly well suited because of the long lead time required to bring the camera up to speed once a random event had been discovered. Typical of such random events are: the passage of slubs or pills in fibers across critical yarn-handling areas; the rupture of pressure vessels under excessive pressure; and rapid chemical reactions or mechanical effects following a heatup period, such as is exemplified by the rupturing of a water-sprinkler unit in the heat of a fire.

Although when the first camera was proposed some consideration had been given to using 35mm film in order to take advantage of the large format and excellent picture quality, it was decided that for bird photography the 16mm size would suffice. Upon reviewing the qualifications of the camera to be built for the laboratory, however, it was felt that the 35mm format offered a number of advantages over 16mm. Among these was the fact that more types of emulsion are available in 35mm film than in 16mm since the 35mm is a fully professional size, whereas the 16mm is intended for professional or amateur use. In addition, the 35mm format provides four perforations per full frame. This made it possible to pick up a strobe synchronizing pulse from each quarter frame, and by means of suitable electronic circuitry to secure either full-, half- or quarter-frame sequences at will.

*Comparison of Operating Features*

The 35mm camera, like the 16mm version, consists of a film-supply chamber with its film metering system; a camera body proper, which houses the film chute, the optical system with its focusing viewfinder, the strobe synchronizing pickup and the driving rolls; and a take-up chamber (see Fig. 5). However, since its intended scope of operation was far wider, nearly all these elements have been altered to improve precision or flexibility as required.

Since it was intended to use the camera at rates of 100–3000 full frames/sec. an electronically controlled variable-speed motor was directly connected to the high-inertia roller by means of a flexible coupling. This motor is capable of producing up to $\frac{1}{2}$ hp and operating at 100–12,000 rpm, and it incorporates a

rapid-response speed regulation circuit. The electronic control circuitry was incorporated into the overall control console of the camera (see Fig. 4).

Since the new camera was to operate over a very wide speed range, it was felt that the simple mechanical timing system for controlling run duration, as used in the original camera, would not be sufficiently precise, particularly from the standpoint of precluding damage to the camera due to overrun of the film at the point where there is no longer sufficient film in the upper supply chamber. The prevention of overrun was particularly important because it was intended that the camera be used with the new high-strength Cronar† film base.

*Overrun Prevention*

Several arrangements were developed for preventing the overrun of film from the upper chamber; however, the one finally selected was a positive frame count. A three-decade, reversible, electronic counter located in the control console accurately tallies the number of frames existing in the upper festoon chamber and provides a direct display of the instantaneous full-frame count. As film is manually fed into the chamber, a sprocket with a cam-controlled microswitch counts in one pulse for each full frame. During the count-in period, a count-in push-button switch must be pressed manually. Release of this button returns the counter to its normal count-out condition. As film is withdrawn from the upper chamber either by action of the drive rolls as in normal operation of the camera, or manually by turning the take-up spool handle, the count is automatically subtracted from the register tally by means of pulses secured from the perforation-scanning system.

As mentioned before, there are four perforations per full frame and thus four output pulses of the perforation scanning circuit per full frame. This signal must first be put through two scale-of-two count-down circuits to provide a single output pulse to the counter for each four-perforation group. The signal for synchronizing the firing of the stroboscopic light source with the passage of film through the camera is drawn from various points in this count-down circuit as desired for either full-, half- or quarter-frame operation. A pair of snap-in masks is provided which establish in the film gate the proper quarter- and half-frame format.

The long, narrow format is particularly valuable in studying the type of subject usually encountered in high-speed photography in that there is usually one very long axis, as in the handling of thread-lines. Also in the transport of small particles, as in sprays, there is nearly always a very long preferred axis and a relatively short axis perpendicular to it. Again in studying the action of relay contact leaves, a long, narrow format is quite satisfactory, especially when it gives a fourfold increase in the number of frames possible, with no attendant loss in resolution along the major axis dimension.

An electronic duration-control circuit, having a range of 1/30 to 3 sec, provides power to the rotary solenoid, with controls located on the console panel. Contrary to the system used in the 16mm camera, it is not necessary to reset the camera for a second run should a second random event occur immediately following the first, or even if a number of random events occur in close order, each triggering one cycle of operation of the camera at its preset duration. However, overriding all other controls, a low-count signal from the electronic counter prevents any operation of the camera under such conditions as would cause the film supply to fall below a predetermined low count. This low-count figure has been set at 70 whole frames, since it has been determined that between 20 and 30 full frames coast through the camera following the receipt of a low-count signal or the normal stopping of the camera by the duration control. A count-reset button is provided for re-establishing zero count at the time film is being newly loaded into the camera. All counting circuits have been designed to have almost perfect d-c response so that the count of film in and out of the camera is accurate at any speed of operation. This was necessary to avoid inadvertent removal of film with no removal of count from the electronic tally, which would result in a dangerous condition in the camera. The camera has been tested in the following fashion.

A low count having been set up in the camera, sufficient film was then fed in to bring the count to 71 full-frame count. The camera was then run with any duration-control setting. Under these conditions, the camera went through a complete legitimate cycle for 1 frame plus the coast-down time of the camera, which was about 30 frames.

*Triggering Techniques*

The trigger input circuit has been designed for greatest possible flexibility, since it is anticipated that many different types of trigger will be used with the camera. It will operate reliably from a 0.1 v positive or negative signal pulse. Experiments have been made with a number of input devices, such as strain gages in the case of pressure-vessel rupture, microphones, crystal accelerometers, photocells and many others, including direct-contact switching. In a study of droplet formation, the droplet was allowed to pass a photocell trip system and thus set off the camera. In studying the action of a sprinkler system unit, a spiral of conductive paint was applied to the outer surface of the glass vial which provided the breaking element. This glass vial contained a volatile fluid which, under the influence of heat, caused the rupture of the vial and the opening of the spray valve. In taking the picture of a balloon burst, a signal from the balloon was obtained by means of a small piezoelectric microphone just touching the outer surface of the balloon. The first pressure wave striking the microphone set off the camera, and a satisfactory sequence of the rupture of the balloon from the first possible instant was secured.

*Results*

These cameras have provided high-speed photographs for the study of a number of subjects which could not have been successfully covered by any other means. In addition, it has been possible to cover up to 20 individual events on a single 100-ft roll of film, rather than expending this amount of film on each short event. The attendant saving in film cost and in developing, processing and analysis time has been most valuable. The uniformity of film velocity achieved in the camera has aided in transcribing motion information from the film to time-displacement records with a minimum of time adjustment.

To make possible the precise measurement of velocities and accelerations from these films, a timing signal is applied by means of a neon bulb which impresses an image along the perforation area on one side of the film. This timing lamp can either be driven from a 60-cycle line, in which case a series of pulses at 1/120-sec intervals is impressed along the film, or a signal can be secured from a suitable time-base generator to provide either 100/sec or 1000/sec pulses along the edge of the film. The extreme constancy of motion of the film has made it possible to use the camera as a precision streak or oscillographic camera in addition to its use with framing strobe equipment.

It is felt this unique method of film transport with its attendant possibilities for immediate response to a triggering signal should find wide application in the study of rapid events.

**Acknowledgments**

The author wishes to acknowledge the contribution made to the success of this camera by R. J. Kerr, by whom the electronic circuitry of both cameras was developed, and by L. C. Eichner, of L. C. Eichner Instruments, Clifton, N.J., who designed and fabricated the cameras. In addition, acknowledgment is also in order for the generous assistance and valuable suggestions given by Prof. L. J. Hooper, of Worcester Polytechnic Institute, and C. H. Greenewalt, for whom the original 16mm camera was produced.

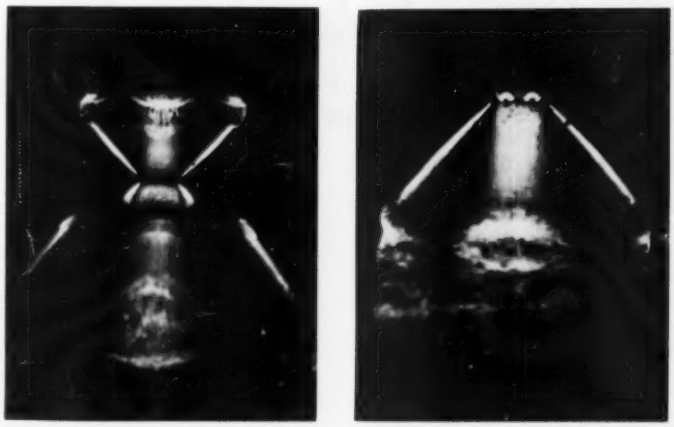
† Trademark for du Pont's polyester photographic film base.

The general outlines and many of the details of the 5th International Congress on High-Speed Photography, to be held at the Sheraton-Park Hotel, Washington, D.C., October 16–22, have now fallen into place. Complete information about the Congress, including registration forms, will be included in a booklet now in preparation and expected to be available early in August.

## U.S. Government Participation

In the words of the U.S. House of Representatives Committee on Foreign Affairs, recommending adoption of a Resolution in support of the Fifth Congress (previously passed unanimously by the Senate and subsequently adopted in similar fashion by the House of Representatives): "The International Congress on High-Speed Photography has received recognition and support from the governments of the respective host countries since the first Congress was held in Washington, D.C. (under the sponsorship of SMPTE) in 1952."

The operative part of the Concurrent Resolution itself, which was introduced into the Senate by Senator Warren Magnuson, Chairman of the Senate Committee on Interstate and Foreign Commerce, states: "That it is the sense of the Congress that all interested agencies of the Federal Government should participate actively to the greatest practicable extent in the Fifth International Congress on High-Speed Photography to be held . . . under the sponsorship of the Society of Motion Picture and Television Engineers."



**Left: Fractional microsecond Kerr-cell exposure of colliding detonation waves in explosives; right: fractional microsecond Kerr-cell exposure of detonation front in notched explosive charge.** (*Photos: Ballistic Research Laboratories, Aberdeen Proving Ground, Md.*)

Backed by the support of the U.S. Congress, the Federal Department of Defense has provided valuable material and financial aid for the Congress, and other Federal agencies are planning active participation in its work. Besides contributions to the technical program, displays and demonstrations of equipment by government institutions will be included in the Exhibit area.

## Organization of the Congress

At the head of the Congress structure, the following Committee of Honor represents the multiplicity of interest in high-speed photography applications throughout government and industry:

*Dr. Detlev W. Bronk*, President, National Academy of Sciences

*Dr. John M. Clark*, General Manager, Photo Products Dept., E. I. du Pont de Nemours & Co.

*Edward P. Curtis*, Vice-President, Eastman Kodak Company

*Donald W. Douglas, Sr.*, Chairman of the Board of Directors, Douglas Aircraft Company

*Dr. Harold E. Edgerton*, Department of Electrical Engineering, Massachusetts Institute of Technology

*Dr. James B. Fisk*, President, Bell Telephone Laboratories, Inc.

*Dr. T. Keith Glennan*, Administrator, National Aeronautics & Space Administration

*G. K. Hartmann*, Technical Director, U.S. Naval Ordnance Laboratory

*Dr. James R. Killian, Jr.*, Chairman of the Corporation, Massachusetts Institute of Technology

*Dr. Paul E. Klopsteg*, Chairman of the Board of Directors, American Association for the Advancement of Science

*Dr. William H. Pickering*, Director, Jet Propulsion Laboratory, California Institute of Technology

*Dr. Simon Ramo*, Executive Vice-President, Thompson Ramo Wooldridge Inc.

*Dr. C. Guy Suits*, Vice-President, General Electric Company

*Dr. Theodore von Kármán*, Chairman, Technical Advisory Board, Aerojet General Corporation

*Dr. Herbert F. York*, Director of Defense Research and Engineering, Department of Defense

CHAIRMAN OF THE CONGRESS: *Max Beard*, U.S. Naval Ordnance Laboratory — Address: 10703 E. Nolcrest Dr., Silver Spring, Md., U.S.A.

DEPUTY CHAIRMAN: *Prof. Dr.-Ing. H. Schardin*, Rosenstrasse 10, Weil am Rhein, Baden, West Germany

The detailed work of arranging the technical program of the Congress is in the hands of the following men:

Associate Chairman and Program Coordinator: *Morton Sultanoff*, Ballistic Research Labs., Aberdeen Proving Ground, Md., U.S.A.

Associate Papers Program Chairman: *Richard O. Painter*, General Motors Proving Ground, Milford, Mich., U.S.A.

Associate Program Chairman for Papers From Abroad: *Dr. J. S. Courtney-Pratt*, Room 1D-449, Bell Telephone Laboratories, Murray Hill, N.J., U.S.A.

Associate Program Chairman in Charge of Film Showings: *James A. Moses*, U.S. Army Signal Corps—Address: 1202 Oberlin Dr., Bucknell Hgts., Alexandria, Virginia, U.S.A.

Foreign delegates, who have been responsible for gathering papers and promoting interest in the Congress in their own countries, are:

*Belgium:* F. TOPFER, 15 rue Sohet, Liège, Belgium

*Canada:* ALEXANDER EASSON, Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ontario, Canada

*Czechoslovakia:* VACLAV KOLAR, Institute of Hydrodynamics, Solinova 7, Praha 6, Dejvice, Czechoslovakia

*France:* Ing. Mil. en Chef de 1° Cl. P. FAYOLLE, Laboratoire Central de l'Armement, Fort de Montrouge, Arcueil/Seine, France

*Germany:* Prof. Dr.-Ing. H. SCHARDIN, Rosenstrasse 10, Weil am Rhein, Baden, West Germany

*Greece:* Prof. Dr. P. SANTORINI, Université Technique

Nationale, Laboratoire de Physique Experimentale II, P.O.B. 49, Athens, Greece

*India:* Prof. KARTA SINGH, Head of Faculty of Chemistry and Metallurgy, Institute of Armament Studies, Kirkee, Poona 3, India

*Israel:* G. NAHMANI, Ministry of Defense, Scientific Department, Hakirya, P.O.B. 7062, Tel-Aviv, Israel

*Japan:* TSUNEYOSHI UYEMURA, Institute of Industrial Science, University of Tokyo, Yayoi-cho, Chiba City, Japan

*Netherlands:* Dr. J. G. A. de GRAAF, Central Technical Institute, T.N.O., Koningskade 5, The Hague, Netherlands

*Norway:* KAYE WEEDON, Boks 137, Ramstad near Oslo, Norway

*Sweden:* Civ. Ing. TRYGGVE RAMQVIST, Forsvarets Forskningsanstalt, Stockholm 80, Sweden

*Switzerland:* Prof. Dr. J. EGGERT, Photographisches Institut der Eidgenössischen Technischen Hochschule, Zürich, Sonneggstr. 5, Switzerland

*U.S.S.R.:* A. I. TCHERNYI, Gularnaya Str. 4 App. 5, Leningrad-3, U.S.S.R.

*United Kingdom:* Dr. R. F. SAXE, Queen Mary College, Mile End Rd., London E. 1, England

In their work of collecting technical contributions the Foreign Delegates have been assisted by the SMPTE National Regional Papers Committee Chairmen in their respective areas.

GENERAL CHAIRMAN OF LOCAL ARRANGEMENTS: *Byron Roudabush*, Byron Motion Pictures, Inc., 1226 Wisconsin Ave., N.W., Washington 7, D.C.

Serving under Mr. Roudabush are the following Chairmen:

Exhibits: *Keith Lewis*, Eastman Kodak Company, 1000 Connecticut Ave., N.W., Suite 1101, Washington 6, D.C.

Registration: *Howland Pike*, Ansco, 3408 Wisconsin Ave., N.W., Washington, D.C.

Government Liaison: *Adm. Robert S. Quackenbush, Jr.*, 2412 North Quincy St., Arlington, Va.

Hotel Arrangements: *Arthur Rescher*, Capital Film Laboratories, Inc. 1905 Fairview Ave., N.E., Washington, D.C.

Interpretation: *Garland C. Misener*, Capital Film Laboratories, Inc., 1905 Fairview Ave., N.E., Washington 2, D.C.

Public Address and Recordings: *J. Clinton Greenfield*, Motion Picture Sound Dept., U.S. Naval Photo Center, Anacostia 20, D.C.

Projection: *Wilson E. Gill*, Wilson Gill, Inc., 1 Thomas Circle, Washington, D.C.

Hospitality: *Fred W. Gerretson*, E. I. du Pont de Nemours & Co., Inc. National Press Bldg., Washington, D.C.

Reception: *Nathan D. Golden*, Director, Scientific Motion Picture & Prod., Business & Defense Services Adm., Dept. of Commerce, Washington 25, D.C.

Banquet: *Dudley Spruill*, Byron Motion Pictures, Inc., 1226 Wisconsin Ave., N.W., Washington 7, D.C.

Entertainment: *Dean F. Lawson*, Eastman Kodak Co., 1350 Okie Street, N.E., Washington 13, D.C.

Ladies' Committee: *Henry M. Fisher*, 4003 Underwood St., Chevy Chase 15, Md.

Co-Hostesses: *Mrs. Keith Lewis*, 7117 W. Greenvale Pkwy., Chevy Chase, Md.; and *Mrs. Garland Misener*, 915 Clemson Dr., Alexandria, Va.

*SPSE Symposium on High-Speed Processing, in conjunction with 5th International Congress on High-Speed Photography, October 14 and 15, Shoreham Hotel, Washington, D.C. For more details, see p. 500.*

Closed Circuit TV: *Lewis Blair*, Walter Reed Army Medical Center, Washington, D.C.

Transportation: *Jack Jiruska*, P.O. Box 2, Annapolis, Md.

Awards Session: *Joseph E. Aiken*, 116 North Galveston, Arlington, Va.

Auditor: *Charles E. McGowan*, 236 Jefferson St., N.W., Washington, D.C.

Publicity: *Stuart Cameron*, RCA Press Relations, RCA Bldg., 1725 K St., N.W., Washington 6, D.C.

## Papers Program

As a result of the efforts of the Topic Chairmen (listed in the *November 1959 Journal*, p. 771), the National Regional Papers Committee Chairmen and the Foreign Delegates, well over 100 papers have been submitted. These are still in process of review for their technical suitability and interest. So far, 96 papers have been accepted for presentation at the Congress, and these are listed, by sessions, at the end of this report.

There will be three official languages used: English, French and German. Simultaneous interpretation will be provided for all papers and individual headset 4-channel radio receivers will offer registrants the choice of hearing a paper in any of these languages, with an additional channel for directly tuning in the speaker, moderator or voice from the floor. Professor Stefan Horn, Georgetown University, and his team of interpreters, will provide the translation services.

Since it will not be possible to present all the accepted papers in full, some will be summarized by the author or session chairman and some published only in the Proceedings. This single-volume record of the Congress will include all papers accepted, with abstracts in the three official languages. A number of the important papers will also be published in the *Journal*. In some cases where the subject matter would make it more appropriate, the Society will endeavor to arrange for publication in the Journals of other Societies.

## Congress Arrangements

There will be at least two guest speakers. At the official Opening of the Congress on Monday evening, October 17, the welcoming address will be given by Dr. Crawford H. Greenewalt, President of E. I. du Pont de Nemours & Co. On Tuesday evening there will be a session for the presentation of SMPTE Awards, and J. Lewis Powell, of the Office of the Assistant Secretary of Defense, will be the featured speaker. He will speak on "The Collapse of Time."

For those arriving in Washington on Sunday there will be a social get-together Sunday evening in the Sheraton-Park. It is expected that some outstanding musical entertainment will be provided by the Soldiers' Chorus of the U.S. Army Field Band. Sunday afternoon there will be an opportunity for registrants to attend an impressive Retreat Ceremony at Fort Myer, Va., held in honor of the High-Speed Congress.

A floor show is planned for Wednesday evening, and a dinner on Thursday evening will honor the Foreign Delegates. It should be noted that all the social events planned will be included in the registration fee. Also, tours are available.

For the ladies there will be an interesting program of activities, also covered by an inclusive registration fee. A tour of Washington will be included, tea at one of the foreign embassies, a visit to the White House, and a boat trip down the beautiful Potomac past historic Alexandria to Mount Vernon.

## Equipment Exhibit

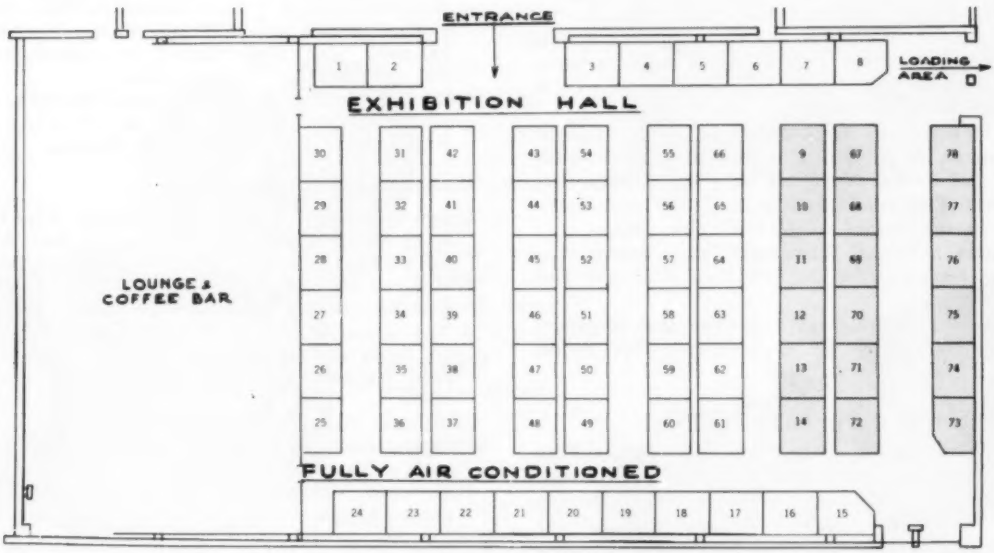
Manufacturers of high-speed cameras, optical goods, laboratory instruments and all types of instrumentation and data-recording equipment will have their latest products available on display for registrants to examine. This feature has been found most useful at previous Congresses. Besides many commercial displays there will be a number of demonstrations and exhibits by government agencies and other public institutions, for whom booths are reserved.

# Exhibit

## Fifth International Congress on High-Speed Photography

Displays and demonstrations of instrumentation and high-speed photographic equipment from manufacturers all over the world. See the newest developments in specialized electronic, optical and mechanical photographic instrumentation devices for all applications.

***Government and Industry Exhibits will be featured.***




**FOR RESERVATIONS**

*contact the Exhibit Chairman:*
*Keith B. Lewis, Eastman Kodak Co.,*
*1000 Connecticut Ave., N.W.*
*Suite 1101, Washington 6, D.C.*

**EXHIBIT SPACE RENTAL RATES**

| | |
|---|---|
| Booths 1-2-3-4-30-31-42-43-54-55 | $350 |
| Booths 15 to 19 incl. and 61 to 66 incl. | 250 |
| All other booths | 300 |

Booths 9 to 14 and 67 to 78 inclusive are being reserved for military and institutional exhibits.

All booths are 8 x 10 ft in size.

**October 17–21, 1960**

**SHERATON-PARK HOTEL, WASHINGTON, D.C.**

The Exhibit Chairman, Keith Lewis, recently opened up the exhibit space to general allocation of booths. So far, the following companies have reserved space for their equipment:

Arriflex Corp. of America
Avco Research & Advanced Dev. Div.
Beckman & Whitley, Inc.
Benson & Lehner, Inc.
Camera Equipment Co.
Computer Measurements Co.
E. I. du Pont de Nemours & Co. Inc.
Eastman Kodak Co.
Edgerton, Germeshausen & Grier, Inc.
Fairchild Camera & Instr. Corp.
Field Emission Corp.
Florman & Babb, Inc.
Dr.-Ing. F. Früngel GmbH
General Aniline & Film Corp. Ansco Systems Development Dept.
Heico, Inc.
Karl Heitz, Inc.
Hi Speed Equipment, Inc.
L-W Products
Motion Picture Enterprises
Neumade Products Corp.
D. B. Milliken Co.
O'Connor Engineering Labs
Photo-Animation Inc.
Photo Sonics Inc.
Polaroid Corp.
Prestoseal Mfg. Co.
Traid Corp.
Westinghouse Elec. Co. Lamp Div.
Wollensak Optical Co.
Carl Zeiss Inc.
Zoomar, Inc.

Other companies wishing to exhibit their products in the space still remaining should contact Keith Lewis, Eastman Kodak Co., 1000 Connecticut Ave., N.W., Suite 1101, Washington 6, D.C.

# 5th Congress-Papers by Session Subjects

**Short Duration Light Sources**

Holdover in Xenon Flash Lamps, *Dr. Harold E. Edgerton and David Cahlander, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.*

The Control of High-Power Xenon Flashes by Magnetic Switching, *Dr. E. J. G. Beeson, AEI Lamp & Lighting Co. Ltd., Milton Road, Leicester, England.*

Flash-Light Source Measurement, *George H. Lunn, Aldermaston, Berks, England*

Utilisation de Lampes Explosives Pour la Photographie par le Système Schardin, *Dr. Louis Deffet, Centre de Recherches Pour l'Industrie des Produits Explosifs (and Laboratoires des Hautes Pressions) Tir National, Place des Carabiniers, Brussels, Belgium; and R. Vanden Berghe, Centre de Recherches Scientifiques et Techniques Pour l'Industrie des Produits Explosifs, Val du Bois, Sterrebeek, Brabant, Belgium.*

Explosive Flashlight—A New Development in an Explosion Light Source, *R. H. Stressau, 7 Summit Rd., Lake Zurich, Ill.; and Jack Gershon, 6245 North Oakley Ave., Chicago, Ill.*

High-Intensity Explosive Light Sources, *Zev Pressman, Stanford Research Institute, Stanford Village, Menlo Park, Calif.*

High-Intensity Fractional Microsecond Light Source, *Earle B. Brown, Farrand Optical Co., 4401 Bronx Blvd., New York, N.Y.*

Millimicrosecond Light Source With Increased Brightness, *Dr. Heinz Fischer, CRRCPT, L. G. Hanscom Field, Bedford, Mass.*

**Applications of Light in High-Speed Photography**

High-Speed Photography Using Ultra-Violet Light to Eliminate Visible Light Masking In Self-Illuminating Events, *R. Wayne Anderson, Photo Lab., The Dow Chemical Co., Midland, Mich.*

Die Anwendung der Mehrfachfunkenkamera bei der Untersuchung von Vorgängen, die eine hohe Gesamtinformation verlangen, *Dr.-Ing. H. Schardin, Rosentr. 10, Weil am Rhein, Baden, West Germany.*

Motion Pictures of Rapid Air Currents and Shockwaves by Means of High-Frequency High-Voltage Sparks, *Dr.-Ing. Frank Früngel, Walter Thorwart and H. G. Patzke, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany.*

A Modern Shadowgraph System for Use in High-Velocity Aeroballistic Ranges, *Paul Thurston, Paul H. Cords, Jr., and W. R. Noyes, Photographic Div., U.S. Naval Ordnance Laboratory, White Oak, Md.*

Submicrosecond Flash Sources, *Dr. Harold E. Edgerton, K. W. Cooper and J. Tredwell, Massachusetts Institute of Technology, Cambridge, Mass.*

A High-Intensity Square Pulse Light Source for High-Speed Photography, *Lemmuel L. Hill, Gas Dynamics Div., U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.*

**Electric and Electronic Shutters**

Image Converter System With Fast Image Group Repetition Rate, *John H. Hett and R. King, Hett Associates, 24 Burton Place, Cresskill, N.J.*

Development of Photographic Electronic Shutter Tubes, *L. Mandell, Imperial College of Science and Technology, London, England.*

The "Astrocon" Tube and Its Application to High-Speed Photography, *A. E. Anderson and G. W. Goetze, Physics Project Laboratory, Westinghouse Research Laboratories, Beulah Rd., Churchill Borough, Pittsburgh 35, Pa.*

A Kerr-Cell Camera With Synchronized Light Source for Millimicrosecond Reflected-Light Photography, *George A. Theophanis, Avco Corp., Research & Advanced Development Div., 201 Lowell St., Wilmington, Mass.*

Multiple Kerr-Cell System With Square Shuttering Characteristics, *Dr.-Ing. Frank Früngel and L. Liebing, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany.*

**Stereo, Spectra and Micro Studies**

Design and Application of a High-Speed Time-Resolving Spectrograph, *Donald Baker Moore and John K. Crosby, Stanford Research Institute, Stanford Village, Menlo Park, Calif.*

High-Speed Spectroscopic Instruments, *Dr. F. D. Harrington, U.S. Naval Research Laboratory, Washington, D.C.*

A Stereoscopic High-Speed Framing-Camera Technique for the Study of Shaped-Charge Liner Collapse, *Bradley O. Reese, Stanford Research Center, Stanford Village, Menlo Park, Calif.*

High-Speed Photographic Recording of Dual Data at High Magnification, *B. H. Amstead, College of Engineering, University of Texas, Austin 12, Texas.*

High-Speed Motion-Picture Photography of Microscopic Phase Changes, *Dr. J. E. Benjamin and J. W. Westwater, 213 East Chemistry Bldg., Division of Chemical Engineering, University of Illinois, Urbana, Ill.*

**Cameras: Sweep and Streak**

An *f*/1 Streak Camera for Use in the Ultra-Violet, *J. Dyson, R. F. Hemmings and R. T. Waters, Associated Electrical Industries Ltd., Research Laboratory, Aldermaston Court, Aldermaston, Berks, England.*

Streak Camera Development at the National Research Council, *E. H. Dudgeon, National Research Council, Division of Mechanical Engineering, Ottawa, Canada.*

The Improved *f*/10 Sweeping-Image Camera: A Versatile Model for Explosive Research, *Berlyn Brixner, P.O. Box 1663, Los Alamos, N.M.*

A High-Speed Rotating Mirror With Greater Dynamic Resolution, *Willard E. Buck, Box 357, Boulder, Colo.*

VFK-UVQJM High-Speed Drum Camera, *Jam Hampl, Meopta Optics and Fine Mechanics, Research Institute, Prerov, Czechoslovakia.*

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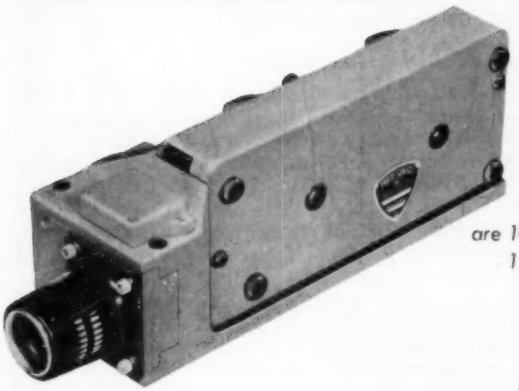

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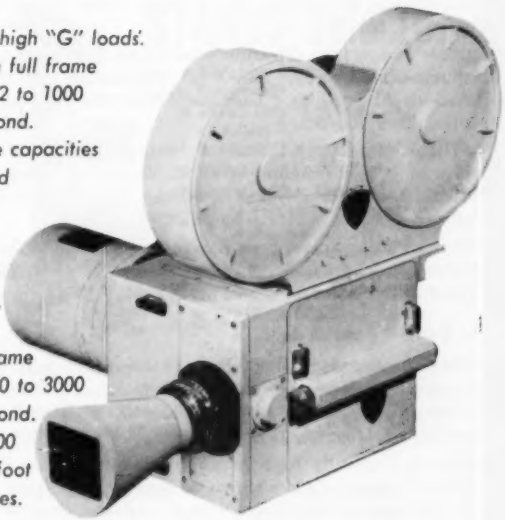

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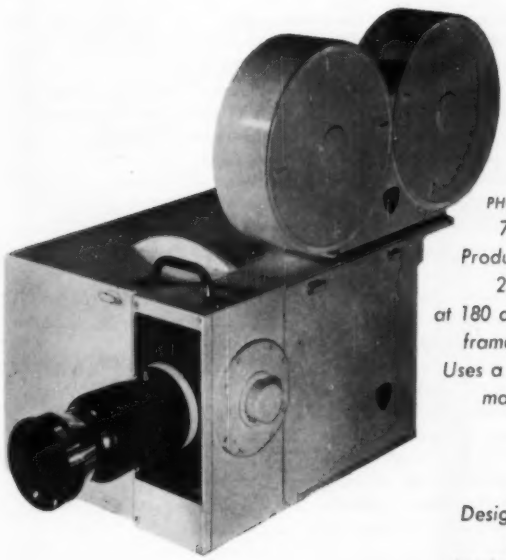

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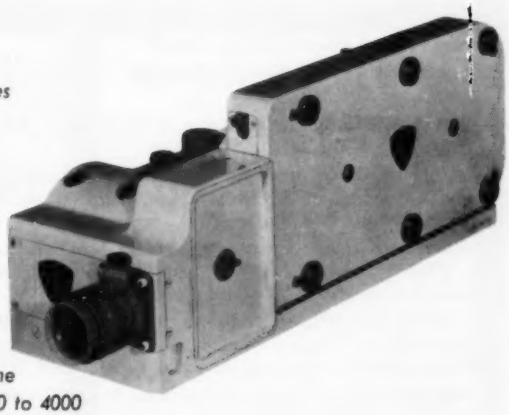

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**Cameras: Rotating Mirror and Smear**

The CORE Camera (Continuous Receptivity—One Rotating Element), *J. N. Whyte, A.R.D.E., Fort Halstead, Sevenoaks, England.*

A New Ultra-High-Speed Framing Camera Combining a Rotating Mirror With a Film Drum, *T. Uyemura, Institute of Industrial Sciences, University of Tokyo, Yayoi-Cho, Chiba-City, Japan.*

Model 200, Reflecting Optics, Sweep Camera, *Thure Anderson, 18829 Lamson Rd., Castro Valley, Calif.*

Smear-Camera Techniques, *T. P. Liddiard, Jr., and B. E. Drimmer, U.S. Naval Ordnance Laboratory, White Oak, Md.*

**Intensification Techniques**

High-Sensitivity Television as an Aid to Low Light-Level Photographic Recording, *B. A. Bang, Bendix-Friez, 1400 Taylor Ave., Baltimore, Md.*

Electronic Image Intensification—An Image Intensifier Using Cathode-Conductivity, *Robert A. Chippendale and J. R. Folkes, A. E. I. Research Laboratory, West Road, Templefields, Harlow, Essex, England.*

Very-High-Gain Image-Intensifier Systems and the Photography of Single Photons With Miscrosecond Time Resolution, *Martin L. Perl and Lawrence Jones, Physics Dept., University of Michigan, Ann Arbor, Mich.*

Tirage des Photographies Sous-Exposées par les "Contrasteurs Optiques," *Miche! Cloupeau, Laboratoire de Recherches Electroniques de la Sorbonne, 11 rue Pierre Curie, Paris 5, France.*

**Flash X-ray**

50-Millimicrosecond Flash X-Ray Photography System for Hypervelocity Research, *Dr. W. P. Dyke, Linfield Research Institute, McMinnville, Ore.; and Frank J. Grundhauser, 210 Ford St., McMinnville, Ore.*

Installation Triple de Radiographie Eclair à 600 kv, *Dr. J. Viard, Poudrerie Nationale, Sévran, Seine-et-Oise, France; and L. Beaudouin, 16 Rue Roger Salengro, Aulnay s/Bois, Seine-et-Oise, France.*

X-Ray Flash Cinematography of Small Objects, *Heiny Alberti, Dr.-Ing. Frank Früngel and Walter Thorwart, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany.*

Megovolt Flash X-Ray Equipment, *E. W. Walker, A.W.R.E., Aldermaston, Berks, England.*

Applications of Flash Radiography, *J. S. McVeagh, A.R.D.E., Sevenoaks, Kent, England.*

X-Ray Flash Cinematography up to 12,000 Images/S., *A. Stenzel, Hauptstr. 193, Weil am Rhein, Germany; and Dr. G. Thomer, Haupstr. 274, Weil am Rhein, Germany.*

Application of Image Intensifier in Flash Radiography, *Dr. G. Thomer, Haupstr. 274, Weil am Rhein, Germany; and Dr. Rudi Schall, Rosenstr. 11, Weil am Rhein, Germany.*

High-Speed Radiographic and Optical Techniques Applied to Hypervelocity Impact Studies, *J. William Gehring, Jr., Ballistic Research Laboratories, Aberdeen Proving Ground, Md.*

Measurements on the Density of Gas in an Argon-Discharge by Soft X-Ray Flashes, *Karl Vollrath, Rosenstr. 12, Weil am Rhein, Germany.*

**Unusual Techniques**

New Methods in Design and Computing for Special Optical Systems, *Raphael Boolsky, Ave. de Miremont 10, Geneva, Switzerland.*

Unusual Application of Optical Instrumentation at NOTS, *D. Keyes, W. Koiner, W. Lambert, G. Silberberg and D. Tiemann, USNOTS, China Lake, Calif.*

Some Unconventional Methods of High-Speed Photography, *Dr. J. S. Courtney-Pratt, Bell Telephone Labs., Murray Hill, N.J.*

**Cameras: Multiple-Shuttered**

High-Speed Intermittent-See, *Robert L. Rodgers, D. B. Milliken Co., 131 North Fifth Ave., Arcadia, Calif.*

A Rotating-Mirror Framing Camera Based on a Focal-Plane Shutter Principle, *Dr. Sigmund J. Jacobs, J. D. McLanahan and P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.*

The Use of Focal-Plane Shutters in Rotating-Mirror Framing Cameras, *Dr. Sigmund J. Jacobs, U.S. Naval Ordnance Laboratory, White Oak, Md.*

Kerr-Cell Framing Camera, *W. C. Goss, R. 1257, Bldg. 112, Lawrence Radiation Laboratory, University of California, P. O. Box 808, Livermore, Calif.*

Tripod Size High-Speed Framing Camera, *R. J. Krumhansl, 451 La Vista Rd., Walnut Creek, Calif.*

**Materials for High-Speed Photography**

A Comparison of 35mm High-Speed Films Under Forced Development Conditions, *Zev Pressman, Stanford Research Institute, Stanford Village, Menlo Park, Calif.*

High-Speed Direct Recording Papers, *Herman D. Hunt, E. I. du Pont de Nemours & Co., Inc., Photo Products Dept., Parlin, N.J.*

Sur les Causes des Ecarts de Réciprocité aux Tres Courts Temps de Pose, *Dr. Henri Sauvenier, Université de Liège, 1A Quai Roosevelt, Liège, Belgium.*

A Photometric Study of Brief Light Sources Associated With Photographic Emulsions, *M. Philbert and C. Veret, Office National d'Etudes et de Recherches Aéronautiques, 29–39 Ave. de la Division-Leclerc, Chatillon-sous-Bagneux, Seine, France.*

**Applications: Ballistics**

The New Technique for Measurement of Velocity of High-Speed Objects, *W. W. Atkins and D. A. Hall, U.S. Naval Research Laboratory, Washington 25, D.C.*

Study of Chemical Reactions in Gases Emerging From the Muzzle of a Gun by Means of High-Speed Photography, *Prof. Kartar Singh, Faculty of Chemistry and Metallurgy, Institute of Armament Studies, Kirkee, Poona 3, India.*

Microsecond Observations of the Dynamic Response of Explosives to Very High Rates of Loading, *R. H. Stressau, 7 Summit Rd., Lake Zurich, Ill.; and H. Napadensky and J. Savitt, Armour Research Foundation, Illinois Institute of Technology, 10 West 35 St., Chicago 16, Ill.*

High-Speed Measurement of Shock Compressibility of Solids in the 1 Mb Range, *Dr. Rudi Schall, Rosenstr. 11, Weil am Rhein, Germany.*

A Photographic Technique for Observing the Behavior of Porous Materials When Rapidly Compressed, *R. H. Stressau, 7 Summit Rd., Lake Zurich, Ill.; and H. Napadensky and J. Savitt, Armour Research Foundation, Illinois Institute of Technology, 10 West 35 St., Chicago 16, Ill.*

Application of the Slit-Aperture Camera for Observation and Data Acquisition, *Stanley Keen, Development and Proof Services, Aberdeen Proving Ground, Md.*

**Applications: Miscellaneous in Industry**

The Micro-Photography of Dilute Fiber Suspensions Moving at High Speed, *E. L. Scott, The Mead Corp., Chillicothe, Ohio.*

High-Speed Photography in the Development of a New Form of Pulveriser, *Dr. Ronald Jackson, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, England.*

Fundamental Research and New Theories in Canning Machinery as Developed by High-Speed Motion Picture Studies, *C. C. Collier and John J. Larish, 103 East Maple, Hoopeston, Ill.*

A Variety of Applications of High-Speed Photography at Outboard Marine Research Center, *Daniel H. Lamb, Outboard Marine Corp., Research Center, 4109 North 27 St., Milwaukee 16, Wis.*

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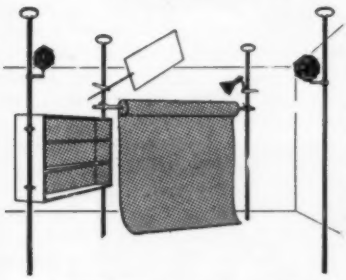

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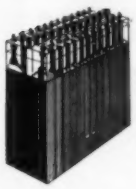

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**Values and Problems of High-Speed Photography**

Method for Analysis of High-Speed Films, *Dr. F. Topfer, 15 Rue Sohet, Liège, Belgium.*

Some Philosophical Aspects of High-Speed Photographic Instrumentation, *Morton Sultanoff, Ballistic Research Labs., Aberdeen Proving Ground, Md.*

What Is the Sensitivity of a Photographic System?, *F. H. Perrin, Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y.*

Study of Resolution Limits in High-Speed Recording, *Thomas E. Holland, Beckman & Whitley, Inc., 993 San Carlos Ave., San Carlos, Calif.*

Value Received — The Use of High-Speed Photographic Techniques in Research and Industry, *R. Wayne Anderson, Photo Lab., The Dow Chemical Co., Midland, Mich.*

**Applications: Survey Papers**

Review of High-Speed Camera Facilities at U.C.L.R.L., *Dr. David C. Oakley, Lawrence Radiation Laboratory, Livermore, Calif.*

Progress in High-Speed Recording at A.W.R.E., *K. R. Coleman and A. Skinner, A.W.R.E., U.K. Atomic Energy Authority, Aldermaston, Berks, England.*

The Evolution of Photographic and High-Speed Cinematographic Techniques at the Laboratoire Central de l'Armement Since the Congress in Paris in 1954., *Dr. Paul Devaux, Laboratoire Central de l'Armement, Arcueil (Seine), France.*

High-Speed Photography Applied to High-Speed Aerodynamics at the National Physical Laboratory, Teddington, *R. J. North, Aerodynamics Div., National Physical Laboratory, Teddington, Middlesex, England.*

A Review of Photographic Instrumentation for Ballistic Data Acquisition, *L. E. Davidson, Engineering Labs., Aberdeen Proving Ground, Md.*

**Application: High-Speed Flow Dynamics**

A Study of the Structure and of the Ultrasonic Emission From A High-Speed Jet of Air Using an Ultra-Rapid Electronic Camera, *François Canac and Mlle. M. Merle, Centre de Recherches Scientifiques, Industrielles et Maritimes de Marseille, 66, rue St.-Sebastian, Marseille (B. du R.), France.*

Photographic Investigation of a Fluid Jet Impinging on a Heated Plate, *G. F. Cochrane and Ralph G. Nevins, Mech. Eng. Dept., Kansas State University, Manhattan, Kansas.*

The High-Speed Photography of Liquid/Solid Impact, *Dr. J. H. Brunton, PCS Laboratory, Free School Lane, University of Cambridge, England.*

A Photomicrographic Arrangement Applied to the Study of the Atomization of Liquid Carburants in a Combustion Chamber, *M. Diamant, 8 Place d'Iéna, Paris 16, France.*

Photographic Study of Time Variations in the Drop-Size Distribution of a Liquid Spray, *M. F. Heidmann, NASA, Lewis Research Center, 21000 Brookpark Rd., Cleveland 35, Ohio.*

High-Speed Photography of Hypersonic Phenomena by Schlieren–Interferography, *H. Oertel, Institut France-Allemand de Ricberches, St. Louis, Haut-Rhin, France.*

Uber das Modellverhalten von Wirbeln im Stosswellenrohr, *Heinz Reichenbach, Katharinenstr. 25, Freiburg i/Br, Germany.*

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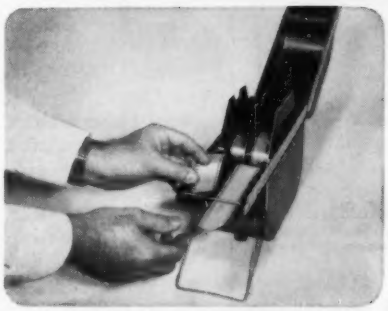

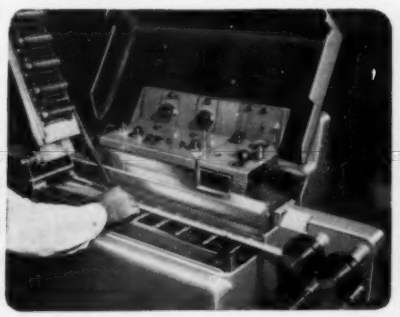

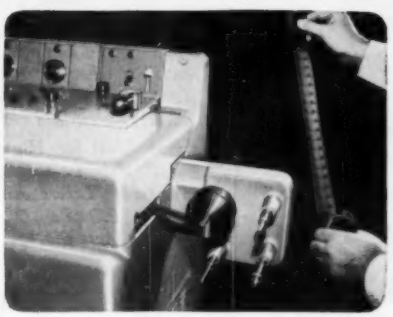

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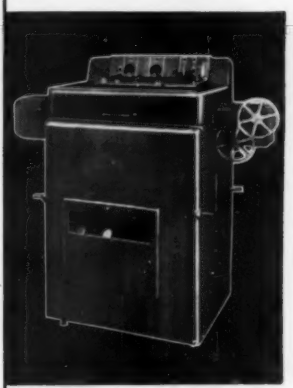
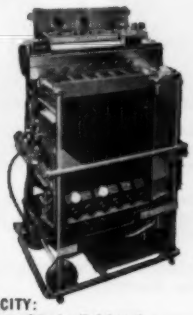
- *Processed film completed at up to 6 feet per minute*

The Mark 3 Automatic Tri-Film Processor develops and dries 16, 35 and 70 mm. film at 1½, 3 or 6 feet a minute. Separate temperature control of the processing solutions from 60 to 110 degrees F. is possible within ±1 degree. Processing is controlled by a mechanical program unit after the film is daylight loaded, and positive squeegee rollers reduce the need of stop baths and interbath rinses. The processor is perfect for newsreels, motion picture rushes, microfilm and all types of negative/positive cinematography where speed plus quality is essential.





**CAPACITY:**
16 mm. 1 to 4 rolls } length
35 mm. 1 to 2 rolls } to
70 mm. 1 roll } 400 ft.

**PROCESS RATE:** 1½, 3 or 6 ft. a minute.

**SPECIFICATIONS**
SIZE: 54" long, 22" wide, 51" high
WEIGHT: 550 lbs.
POWER: 5KVA maximum single-phase: 110 volts, 45 amps., or to customer requirements.

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Maurer 05 Camera Head Only w/built-in features and one 400 ft. mag. ..... 2,000.00
Auricon Pro 200 16 Camera w/VA galvo complete w/amplifier, mike and cable ..... 1,200.00

**Editing** Neumade 35mm film measuring machine w/4 digit counter that measures footage only, 8 frame, 32 tooth sprocket hub with individual controlled tension rollers ..... 40.00
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Spectra 2—Color Meter ..... 200.00
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**Sound** Magnasync recorder, 16mm X-400 ... $ 600.00

**Projection** GPL—Jan Projector w/speakers—Genova Movement ..... 1,000.00

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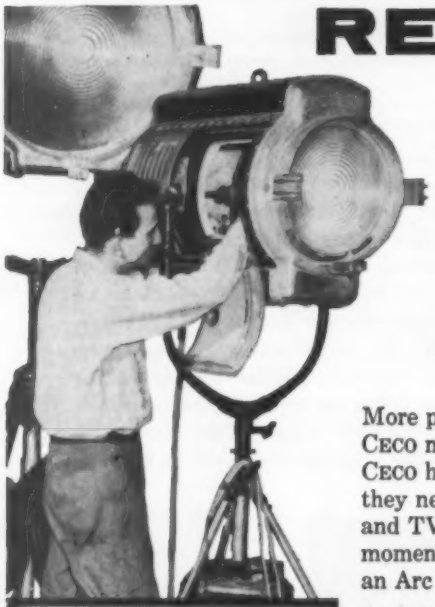

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*Conclusion of list of technical papers to be presented at the 5th International Congress on High-Speed Photography*

**Applications: Miscellaneous**

Application of High-Speed Photography in Nuclear Reactor Development, *George W. Lindholm, Argonne National Laboratory, 9700 South Cass Ave., Argonne, Ill.*

The Use of High-Speed Photography and Photoelastic Coatings for the Determination of Dynamic Strains, *Major C. A. Cole and J. F. Quinlan, U.S. Naval Medical Field Research Laboratory, Camp LeJeune, N.C.; and J. F. Zandman, Instruments Div., The Budd Co., P.O. Box 245, Phoenixville, Pa.*

Underwater High-Speed Photography, *J. V. Pflaum, 2536 Norfolk St., National City, Calif.*

Photographic Problems, Techniques and Instrumentation in Sea Animal Locomotion Studies, *Dr. Irving Rehman, 5153 Tampa Ave., Tarzana, Calif.*

**Control Systems**

Quenching Spark Gaps as Trigger Element in High-Speed Motion Analysis Cinematography, *Walter Thorwart and Dr.-Ing. Frank Füngel, Dr.-Ing. Frank Füngel GmbH, Hamburg-Rissen, Germany.*

Precision Speed Control of a High-Speed Camera, *David Cahlander, Massachusetts Institute of Technology, Cambridge, Mass.*

Remote Control Unit for High-Speed Multiple Motion, *Fred Metlen, 1705 Summit Ave., Boeing Airplane Co., Seattle, Wash.*

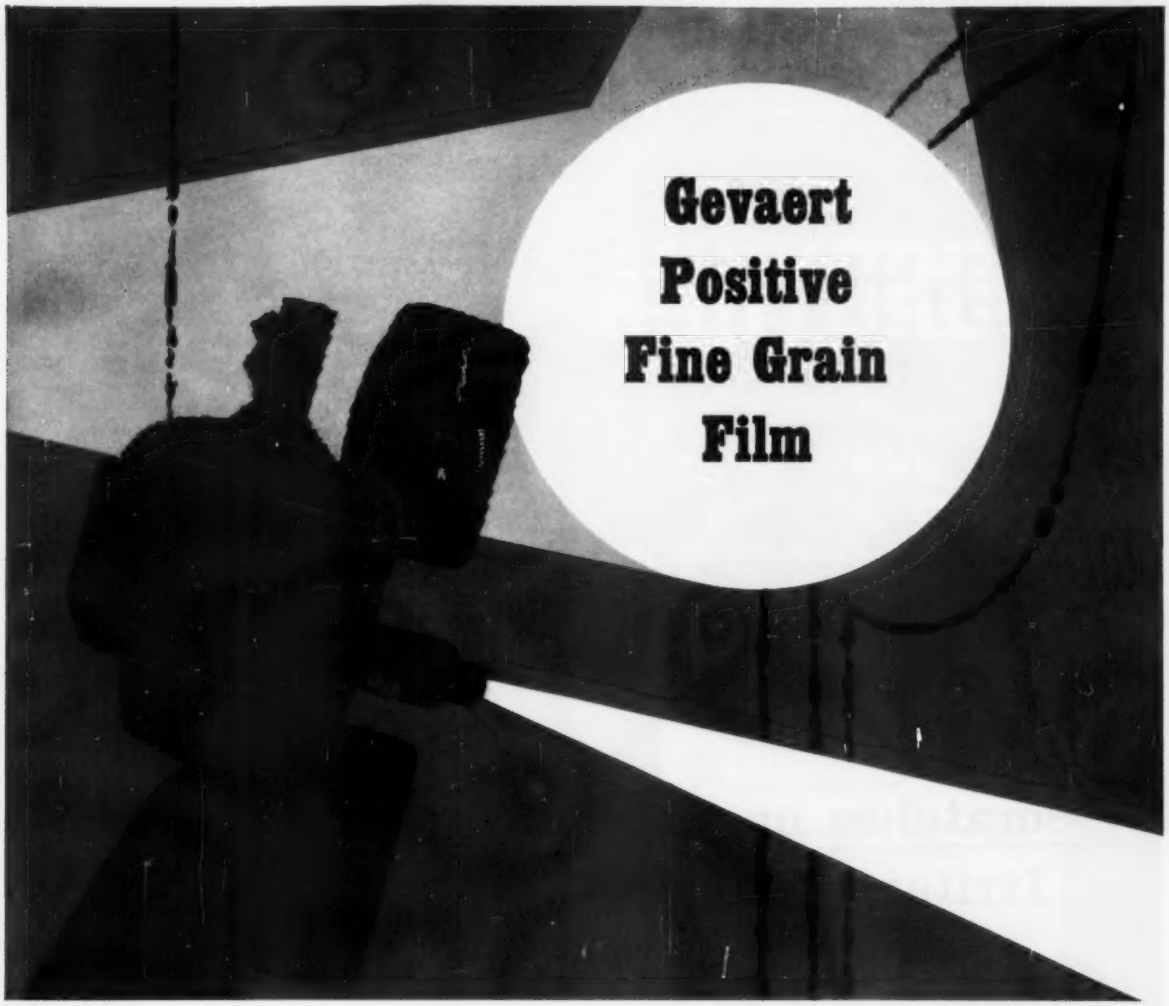
An Automatic Control System for a High-Speed Cine Camera, *John G. G. Hempson, Ricardo & Co., Ltd., Shoreham-by-Sea, Sussex, England.*

A New Approach to Ultra High-Speed Camera Control, *Gordon A. Greene and E. Godin, Sandia Corp., Sandia Base, Albuquerque, N.M.*

Pulse Program Generator, *Jakob H. Hohl and R. Munger, Research Laboratory, IBM Corp., Zürichstr. 108, Adliswil-Zürich, Switzerland.*

Trigger Unit for High-Speed Camera, *C. P. Johnson and S. A. Lott, Defence Standards Laboratories, Department of Supply, P.O. Box 50, Ascot Vale, W2, Victoria, Australia.*

# Spotlight on

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## SPSE Symposium on High-Speed Processing

The two-day special symposium on new developments in rapid photographic processing, organized by the Society of Photographic Scientists and Engineers in conjunction with the 5th International Congress on High-Speed Photography, will take place at the Shoreham Hotel, Washington, D.C., October 14 and 15. Since the announcement of the symposium in the April *Journal*, p. 274, further information has been received from SPSE on the subject matter to be covered at this meeting, which should be of interest to many of those arriving early in Washington to register for the 5th Congress opening October 16.

Dr. Edward K. Kaprelian, Assistant Director of Research, U.S. Army Signal Research and Development Laboratories, Fort Monmouth, N.J., will preside at several key sessions. The meeting will have as a major goal the exchange of information on "short access time, compact, simplified photographic processing equipment." Dr. Kaprelian will speak on the subject "Future Military and Commercial Applications of Short Access Time Rapid Processing," on October 15.

George T. Eaton, President of SPSE and head of Eastman Kodak's processing research department, will open the symposium on October 14 with an introductory paper, "The Revolution in Photographic Processing." Other subjects to be covered during the two days of sessions are:

*Rapid processing technology.* Novel, simplified chemical application techniques leading to compact, convenient processing equipment, including theoretical and practical aspects of unconventional liquid, gel and other processing methods.

*Photographic chemistry.* Discussions of all aspects of the chemistry of solutions tailored for various specialized applications.

*Photographic emulsions.* Descriptions of the unusual requirements placed on photographic emulsions for various kinds of rapid processing, and results obtainable with newly developed emulsion types.

*Development of film-chemical-application combinations.* The systems aspects of the matching of the several elements contributing to maximum performance in rapid processing.

*Uses for rapid processing.* Requirements for high-speed processing equipment in data handling systems now in use or in development.

*Larger processing machines.* New principles, designs, chemistry, and controls for larger high-volume processing equipment.

*Electrophotography.* New non-silver techniques for recording and rapidly displaying graphic material of all types.

*Future of rapid processing.* Future demands and uses of rapid processing components, equipments, and systems.

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## Education, Industry News

**The SPIE (Society of Photographic Instrumentation Engineers)** Technical Symposium & Exhiborama of Equipment will be held August 1–4 at the Ambassador Hotel, Los Angeles, and will be co-sponsored by the Air Force. Thirty-six technical sessions are scheduled, five of them classified with attendance restricted to persons providing required security clearance. Topics planned for discussion at the classified sessions include Air Force Terrestrial Reconnaissance, Army Battlefield and Combat Surveillance, Miss-Distance and Firing-Error Determination, Rocket Motor Function Evaluation, and SAMOS Subsystem "I." The unclassified sessions include Recent Advances in Geometric Optics, Infrared Recording Systems, Recent Advances in Fiber Optics, High-Speed Sequence Recording, Bright-Screen Projection Systems for Data Display, Extraterrestrial Photoinstrumentation, and other related topics. General Chairman of the Symposium is E. F. Flint of Eastman Kodak Co. Additional information is available from SPIE Press Bureau, P.O. Box 288, Redondo Beach, Calif.

**A regional Seminar** on the Use of Visual Aids in Adult and School Education in Latin America, organized by Unesco with the assistance of the Mexican Government, was held in Mexico City in September 1959. Eighteen Member States of Latin America and a number of international and national organizations were represented. After discussion and consideration of reports a number of recommendations were adopted leading to the systematic use of audio-visual aids in schools and for other educational service. A report translated from Spanish into English, Document Unesco/MC/38, is available from Unesco, Division of Free Flow of Information, Place de Fontenoy, Paris 7.

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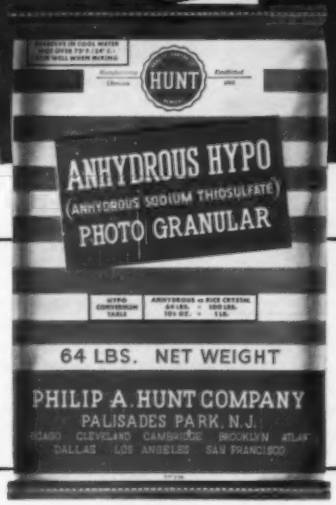


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**A meeting on Development of Information in South East Asia** was held in Bangkok, Jan. 18–29, under the auspices of the United Nations Education, Scientific and Cultural Organization (Unesco). The Bangkok meeting is the first of three such meetings planned to consider the problems of helping underdeveloped countries to build up their information media. Plans have been announced for subsequent meetings at Santiago de Chile in 1961 and Addis Ababa in 1962 to discuss information media in Latin America and in Africa. The Bangkok meeting was attended by representatives of Member States, experts in various types of information media and observers from international organizations.

A number of important points were brought out during discussions on film and television. Discussion on film was limited to nontheatrical films, including documentary, educational, children's and cultural films. Considerable emphasis was placed on the importance of training programs and it was suggested that a regional training center be established for the training of motion-picture and television personnel. It was also noted that a major problem in South East Asia is a shortage of raw stock, and it was suggested that a review of the situation would show that raw stock shortage and lack of equipment (including spare parts) in this region, combined with fiscal and Customs regulations, limit the growth of documentary film making, and consequently the enlightenment and further education of people of the region.

It was also urged that professional film and television organizations should consider possible ways of cooperating with the International Film and Television Council recently established on the initiative of Unesco.

In a general discussion on television, it was noted that television had such sociological importance and community impact that it was an entirely necessary medium for disseminating information and instruction to both city and rural audiences. It was emphasized that in this area (South East Asia) immediate action in long-range planning had become urgent. It was recommended that, in view of the inadequacy of information currently available in this field, as an essential first step, a detailed survey should be immediately undertaken to analyze the problems, experiences and future possibilities of developing television in the countries of South East Asia. It was also suggested that, following the survey, recommendations should be made as to how existing film resources might materially aid new television services.

Intensive training programs and the establishment of experimental television stations was suggested as a possible first step toward the development of television in these countries.

A 51-page report in English has been made as Document Unesco/MC/39 by Unesco's Division of Free Flow of Information, Place de Fontenoy, Paris 7.

**The 16th National Electronics Conference and Exhibition,** in which the Society is a participant, will be held October 10–12 in the Hotel Sherman, Chicago. Participants other than the Society include seven universities (Michigan State, Purdue, Michigan, Notre Dame, Wisconsin, Wayne State and the recently added Iowa State) and the Electronics Industries Assn. Sponsors include the American Institute of Electrical Engineers, Illinois Institute of Technology, the IRE, Northwestern University and the University of Illinois. A number of papers on new developments in electronics are scheduled for the technical sessions. Exhibits Chairman is John S. Powers. Additional information is available from National Electronics Conference, Inc., 228 N. La Salle St., Chicago 1.

**At the 20th Annual National Audio-Visual Convention** to be held August 6–9 in Chicago, James W. Hulfish, Jr., NAVA Director of Information, will talk on "The Challenge of the Sixties." He plans to survey the development of the audio-visual industry and to review current trends and future prospects. "Meet the Challenge" is the title of an address to be given by G. Herbert True, the well-known psychologist. "Selling to Industry" is the title of a scheduled presentation centering around an analysis of A-V utilization in industry. Participants are Richard B. Lewis, Tom Clemens and Jerry Kemp, all of the A-V Center, San Jose State College, San Jose, Calif.

**Teaching Machines?** will be one of the topics discussed at the Audio-Visual Educa-


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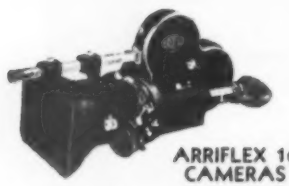

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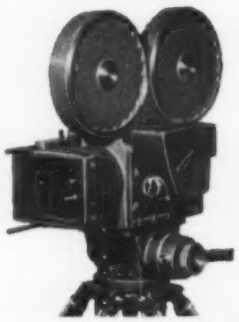

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cleans, conditions and lubricates your film in one easy operation. Non-inflammable, eliminates waxing, absolutely safe —Ecco Model D Applicator $33.00

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tion Forum to be held August 6–8, at the Morrison Hotel, Chicago, as part of the Annual National Audio-Visual Convention. The Forum will open with an all-day screening of Blue Ribbon award-winning educational films, each followed by discussion and evaluation moderated by Richard Edmundson of the Illinois Public Aid Commission and President of the Chicago Film Council, and Reynolds Hungerford of the Chicago Public Schools System.

**Plans for holding the Third Biennale Internationale Photo-Cinema-Optique** April 15–24, 1961, at the new Exposition Center, Rond-Point de la Defense, Paris, have been announced by J. d'Autrevaux, General Commissionary, 15 rue de Bellechasse, Paris 7. The American Express Co. will handle transportation and accommodations for visitors and exhibitors.

**The 63rd Annual Meeting of the American Society for Testing Materials** was held June 26–July 1 in Atlantic City, N.J. An all-day program conducted by the ASTM's new Division of Materials Sciences was held June 27. The day was occupied by two symposia: "Recent Progress in Materials Sciences" and "On the Nature and Origin of Strength of Materials." W. O. Baker, Vice-President of Research, Bell Telephone Laboratories, was guest speaker at the luncheon. His talk covered interdisciplinary laboratories and research and education relating to materials sciences. The Gillett Memorial Lecture, sponsored jointly by ASTM and Battelle, was delivered by R. Carson Dalzell, Assistant to the Director, Division of Reactor Development, AEC. He spoke on "Nuclear Fuel Elements Development." The annual Edgar Marburg Lecture was given by Farrington Daniels, Vice-President of the National Academy of Sciences, who spoke on "The Utilization of Solar Energy." The biennial exhibit of testing apparatus and laboratory supplies opened June 27 and closed July 1.

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The utmost light efficiency is obtained by the use of 6 interference-type multi-layer, all-dielectric beam splitters, and by the elimination of absorbing trimming filters. The heat absorbing glass is eliminated and a cold mirror, of the interference type, is used instead. All of the interference beam splitters are cemented and therefore permit easy cleaning without risk of damage.

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Memory Unit with Reader

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*Keyboard and Punch* with 32 combinations for each color—blue, green, red; with an additional channel for introducing other information such as stop, lap dissolves, etc., and with built-in scene counter. Can also be used with Reader to reproduce duplicate tapes automatically and will permit corrections of the tape and continue with the accepted information. $2,300.00 f.o.b. New Rochelle.

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**Andrew J. Mott, Jr.,** has been appointed Sales and Technical Representative for the West Coast Area for Electro Powerpacs, Inc., a subsidiary of Hydra-Power Corp., 5 Hadley St., Cambridge, Mass. Headquarters for Mr. Mott's warehouse and service work will be Bradford Sales and Service Co., 1237 South San Gabriel Blvd., San Gabriel, Calif. Prior to this appointment he was Photographic Instrumentation Specialist for the Rocketdyne Division of North American Aviation Corp.

**Albert M. Uremovich** has been appointed to the staff of field engineers of Traid Corp., 17136 Ventura Blvd., Encino, Calif. Prior to this appointment, Mr. Uremovich served as Surveillance Sensor Coordinator of the Signal Corps Drone Program at Fort Huachuca, Ariz. He has also been employed on photographic assignments by General Motors, Convair and the U.S. Naval Ordnance Test Station, China Lake, Calif.

**Allen B. DuMont,** a trustee of Rennselaer Polytechnic Institute, Troy, N.Y., since 1945, has been elected Vice-President of the Board. He was graduated from the Institute in 1924 and in 1945 was granted the honorary degree of Doctor of Engineering. Noted for many contributions to the fields of television and electronics, one of his most important projects was the development of the cathode-ray tube. He organized one of the first TV stations in New York, WABD, and later organized WTTG in Washington, D.C., WDTV in Pittsburgh, and the DuMont Television Network.

**Robert D. Hamilton** has been appointed Head of the Systems Engineering Department of Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N.J. He was formerly Consulting Engineer for International Business Machines Corp., Oswego, N.Y., where he was in charge of various projects and operations having to do with radar developments, data processing, digital computing and related fields. He has also been a senior engineer with Allen B. Du Mont Laboratories where he held the post of Electronic Systems Engineer.

**Charles A. Hamilton** has been appointed Director of the Radio and Television Department of Bevel Associates, a public relations and advertising firm of Dallas, Tex. He will supervise radio and television activities for all agency clients. He was formerly senior industrial motion-picture writer-director with Convair in Fort Worth, Tex.

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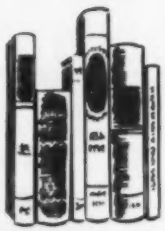

# books reviewed

## TV Tape Commercials

By Harry Wayne McMahan. Published (1960) by Communication Arts Books, Hastings House, 151 East 50 St., New York 22. 110 pp. 5¼ by 8¼-in. Price $4.50.

The author of this book has managed to take a highly technical subject and treat it so that a lay reader can readily assimilate a good working knowledge of TV tape technique.

The first few chapters bring into focus the evolution of tape, documenting some of the actual production problems and how they are handled in this new medium.

Many of the subjects touched upon not only shed light upon the tape technique, but also are applicable to commercial production in general. The writing is handled in a breezy, fresh, easy to read manner which in no way detracts from the information content of the book. Generally speaking, this is a book that should be on the shelf of every individual who has occasion to be conversant with any phase of taped commercials, and this includes production personnel as well as advertising commercial copywriters and producers.

The contents take the reader in chronological order through the history of the evolution of tape, its beginnings, a glance at the problems of commercial production, the specific application of tape to those problems, case histories of some TV tape commercials, a discussion of the comparative advantages of tape and film, and some of the production tools that tape offers to the user.

A variety of commercials requiring production values of different sorts are documented in specific terms. Also under discussion are the characteristics of tape as a medium, its inherent kinship to live TV quality, the immediacy, audio quality, costs, labor problems, etc.

The author is most careful to mention points which are of specific interest to the advertising agencies, a service that will aid the technical workers tremendously, because in so doing, the author gives the layman at least a passing understanding of some of the problems, perhaps preventing some individuals from asking for the impossible. It should, therefore, be made mandatory that all advertising agency personnel having anything to do with TV production read this book several times.

After some of the actual production problems are handled, there is a lucid rundown on the modus operandi of tape itself with many wise squibs of advice to the user. Toward the end of the book some excellent suggestions for TV station use of tape facilities are made, and for this reason, independent station personnel would find the book of great value to them.

Although this is not a technical book in the strict sense of the word, there is much in it of interest to engineers if only to give the slide-rule addicts a peep into the other side of the problem, and to give them some relaxing reading matter with sufficient interest in their own field.

The only negative comment that can be made about this book is that perhaps the author has become a bit over-enthusiastic about the tape medium in the sense that he seems to be prejudiced in a small degree to suggest the use of tape for some applications that might be done a little more efficiently handled on film. (The writer of this review, likewise, may be equally prejudiced in favor of film.) However, in fairness to the author of the book, it must be said that the tape medium is one that does inspire enthusiasm when seen in action, because of the quality and immediacy of the product when properly applied to the commercial or dramatic problem. When properly lit and handled with proper setups, it is undoubtedly superior to film. In its ideal use for maximum perfection, if tape were to be handled with individual setups as is done in film, the ultimate in perfection would be achieved, but this is not the purpose of tape, and this type of treatment would negate the fast working advantages that tape offers.

Included with the book is a bookmark made of a short length of videotape, so the reader can get a first hand look at the material.—*Ernest M. Pittaro*, Dancer-Fitzgerald-Sample, Inc., 347 Madison Ave., New York 17.

## Scientific Publications

**(of the Fuji Photo Film Co., Ltd.) No. 4, 1934-1952**

Published December 1959. Shin Fujisawa, Editor. Distributed by Maruzen Co., Ltd., Tokyo. 131 pp. Paperbound. Price $1.50.

*Scientific Publications* brings together under one cover papers published over a specified period of time by the personnel of the Research Department of the Fuji Photo Film Co., Ltd. Issues 1–3 contain papers published in 1953–55. Number 4 which appears after a lapse of several years coincides in time with the 25th anniversary of the founding of the Company and is made up of papers and abridgments of papers published in the period 1934 to 1952. Many of these papers appeared originally in early issues of the *Journal of the Society of Scientific Photography of Japan*, almost unobtainable in the United States, or they were presented at scientific meetings but apparently not published.

Issue No. 4 contains 19 original reports in Japanese, with abstracts, tables, and captions of figures in English. With the aid of the English portions, the reader who does not understand Japanese often can still glean much information from the papers. Four of the papers deal with the preparation of sensitizing dyes, two with color couplers, two with the fading of silver images caused by residual thiosulfate,

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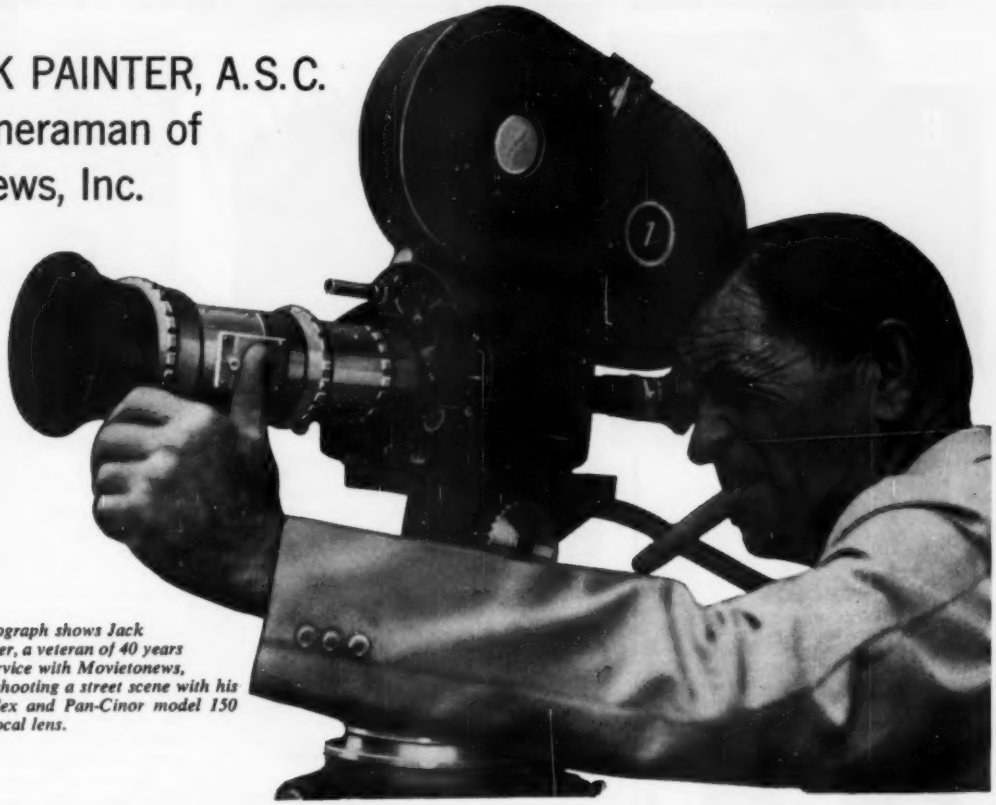

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and two with the construction of sensitometers; others are on the action of 5-bromobenzotriazole in emulsions, hypersensitizing by exposure, the effect of corpuscular radiation on photographic emulsions, recovery of components from waste fixing solutions, a camera for testing resolving power, a meter for measuring silver ion concentration, coating of glass to reduce two-layer reflection, and the chemical composition of commercial emulsions. The paper on the latter subject gives the silver, gelatin, silver iodide, silver bromide, soluble bromide ion, and soluble chloride ion contents of 15 photographic emulsions of Western manufacture. In addition, the issue contains the complete Japanese version of a review article on the use of photographic plates in spectrographic analysis, originally published in 1948, and 22 abridgments, in both English and Japanese, of papers published during the period 1936 to 1947.—*T. H. James*, Eastman Kodak Co., Research Laboratories, Rochester 4, N.Y.

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**Commercial Sound Catalogue No. 132** offers descriptions (including specifications) and illustrations of a wide rage of microphones and speakers produced by Electro-Voice, Inc., Buchanan, Mich. The microphones are categorized according to the type of generating element: crystal, ceramic, carbon, and dynamic; and according to type of pickup pattern: nondirectional (omnidirectional), unidirectional (cardioid and sound spot) and differential (close talking). The catalogue is available upon request to the company.


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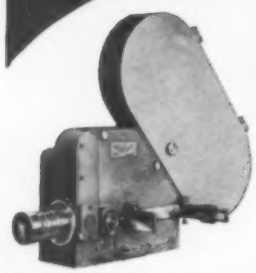

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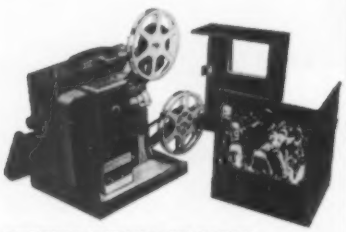

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## section reports

**The Atlanta Section** met on May 10 at WSB-TV with an attendance of 25. Guest speaker Edward Schmidt, Vice-President, Reeves Soundcraft, discussed "The History of Magnetic Striping." Mr. Schmidt gave an interesting presentation of the history of magnetic striping, a field that is much older than most people realize. The early problems and various methods of striping were discussed and slides of historical and contemporary equipment for stripping film were shown.

Most of the basic problems of magnetic striping have been solved, and it has been firmly established in the theatrical and educational fields for five to ten years. It is now also making strong progress in the TV industry. It is felt by many that 16mm single-system sound on a magnetic stripe can rival 35mm optical sound.

The newest field for magnetic striping is 8mm film. This has been slower in developing because small defects that had held the tape away from the recording head have been relatively more serious on the very narrow stripe used on 8mm film than they have been on the broader stripes that can be used on 16mm and 35mm films. However, these problems have now been largely solved, and a good future is now predicted for magnetic striping on 8mm film.

Slides were shown of the Reeves Soundcraft production facilities. After the formal presentation a lively and informative question-and-answer period was held. It was felt generally that this program was

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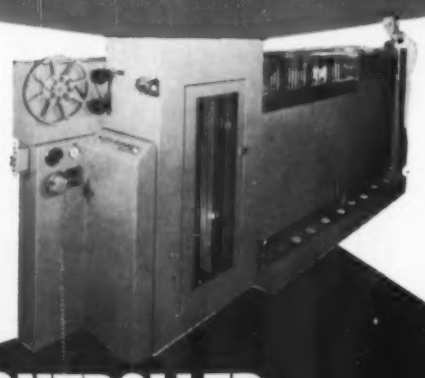

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one of the most instructive that we have had.—Wesley R. Sandell, *Secretary-Treasurer*, c/o Kodak Processing Lab., 4729 Miller Dr., Chamblee, Ga.

**The Atlanta Section** met June 10. Thirty-one members met at Redstone Arsenal, Huntsville, Ala., where they were privileged to take part in a guided tour of the installation. The welcoming address, given by Mr. Green of the Redstone Engineering Staff, was followed by an impressive motion picture showing various types of rockets and missiles. Following lunch at the Headquarters Cafeteria, the tour proceeded to Test Area No. 5. The tour included not only the test firing area, but the Block House or Control Building for the area. An especially interesting area seen on the tour is the Computer Center where the electronic equipment used to obtain and record data on work being completed at Redstone Arsenal and other installations is maintained. The next stop on the tour was the Test Firing Area and the group had the unforgettable experience of watching a test firing of one of the Saturn rockets. The Saturn and Jupiter rockets were viewed at fairly close range and an official guide was at hand to answer questions.—C. W. Wood for Wesley R. Sandell, *Secretary-Treasurer*, c/o Kodak Processing Lab., 4729 Miller Dr., Chamblee, Ga.

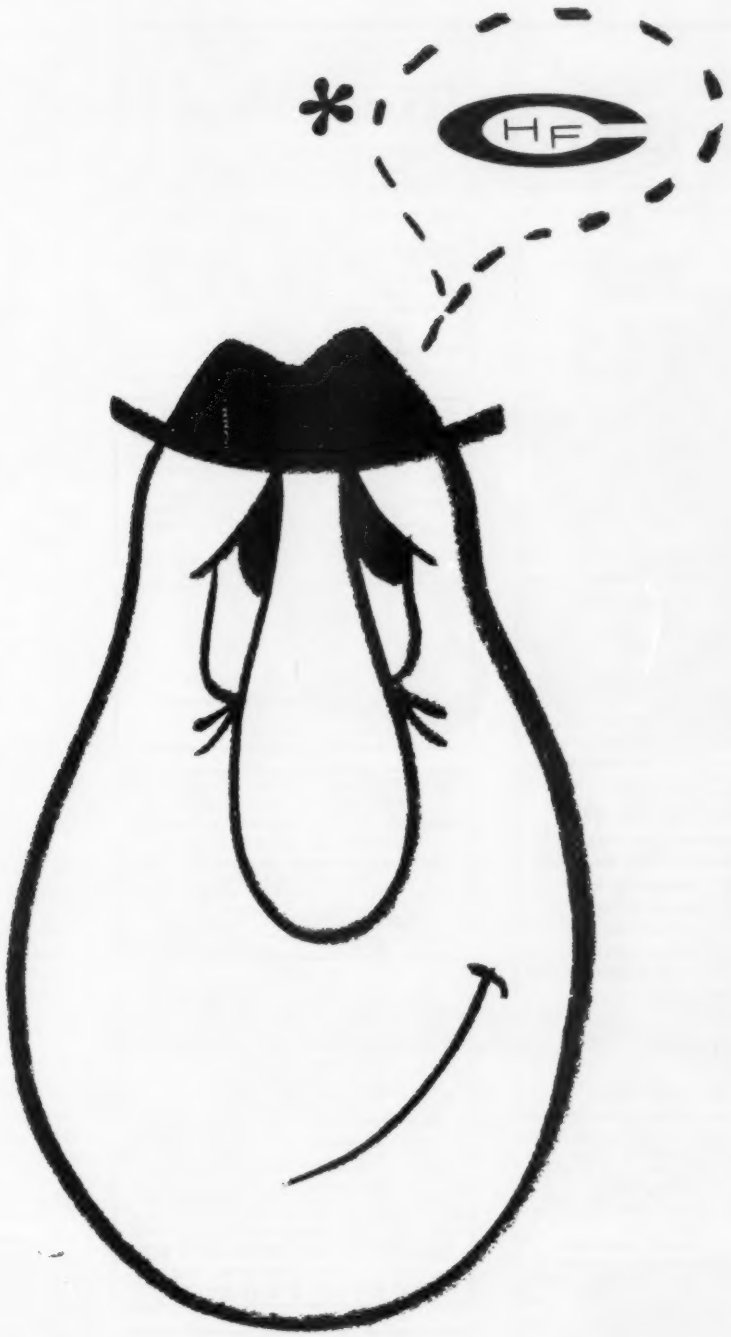
**The Boston Section** met on June 19 to hear a talk on "Magnetic Tape Synchronization" by Loren Ryder of the Magnetic Sales Corp., Hollywood. The meeting, which was held at the WBZ-TV Studios, was attended by 83 members and guests. Members of the Society of Photographic Scientists and Engineers were among the invited guests.

Mr. Ryder described a system which permits the synchronization of any motion-picture camera with any make of tape recorder by the addition of a synchronizing generator to the camera and an auxiliary sync recording head to the tape recorder. The sync signal on the tape can be used to drive the projector in synchronization with the tape recorder on playback. An ingenious method of maintaining synchronization between a tape made with a wild camera was also demonstrated. A demonstration of the various other systems was also given.

Interest in Mr. Ryder's talk was extremely high. Many of the members and guests preferred to stay on in the auditorium for further discussion rather than adjourn to the lobby where doughnuts and coffee were served at the conclusion of the meeting through the courtesy of Eastman Kodak Co.—Robert M. Fraser, *Secretary-Treasurer*, c/o Itek Corp., Waltham 54, Mass.

**The Toronto Group of the Canadian Section** met May 31. The meeting included a tour of the television and radio facilities of the Canadian Broadcasting Corp. This was the Section's first Ladies Night and the program of general interest was very well received.

Refreshments were served at the conclusion of the tour and CBC technical personnel, who had acted as guides on the

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tour, conducted a question-and-answer period. Reg Horton, Director of Technical Operation, CBC Toronto, deserves our hearty thanks for arranging these activities.—Lou T. Wise, *Chairman*, Program Committee, Toronto Group, Canadian Section.

(Ed. Note: This is the last report to be submitted by Mr. Wise in his capacity of the Chairman of the Program Committee, Toronto Group. He is succeeded by Robert MacKenzie of MacKenzie Equipment Co.)

**The Hollywood Section** met on June 21 at the Walt Disney Studios in Burbank, with an attendance of 250. Guests speakers were Major Daniel McGovern, Commander, Det. 1, 1352nd Motion Picture Squadron, Vandenberg Air Force Base; and Major Albert P. White, Chief, Electronic Counter Measures Branch HQ, 15th Air Force Strategic Air Command.

William Gibson of Douglas Aircraft provided an interesting opening 16mm color film consisting of clips collected over the past few years showing various types of missiles which have misfired and exploded either during or shortly after take-off.

In his discussion of "Photographic Instrumentation at Vandenberg Air Force Base," Maj. McGovern gave a very human and interesting description of the photographic instrumentation work being done at Vandenberg Air Force Base. He described the formation of the unit, indicated its recent growth, and showed an aerial view of the new photographic building which will house a complete motion-picture laboratory.

Maj. White outlined the type of activity encompassed by electronic countermeasures, gave several examples of such activity during World War II and touched upon more recent efforts in this very complex application of electronics. His subject was "Background and Use of Electronic Countermeasures, Their Use Actively, Passively and in Reconnaissance."—Ralph E. Lovell, *Secretary-Treasurer*, 2554 Prosser Ave., Los Angeles 64.

**The New York Section** met on June 8 at the Museum of Modern Art with an attendance of 453. Guest speaker Dr. William E. Glenn, Applied Physics Section, General Electric Company, discussed "Thermoplastic Recording."

Dr. Glenn presented an expanded version of the paper he read at the 87th SMPTE Convention in Los Angeles. He explained the process and described the equipment used, stating that the actual recording is done in a vacuum. Dr. Glenn illustrated his talk with excellent slides showing the details of the equipment as well as data charts. General Electric, he said, is now using the process for data reduction purposes and continued development is being carried out to make it available for use by others. The audience watched a showing of a thermoplastic record of off-the-air television at the conclusion of his talk.

The customary coffee break was dispensed with due to the large attendance and the meeting went into a lively question-and-answer period with a large number of the members present taking part.—James W. Kaylor, *Secretary-Treasurer*, c/o Movielab Film Labs, Inc., 619 W. 54 St., New York 19.

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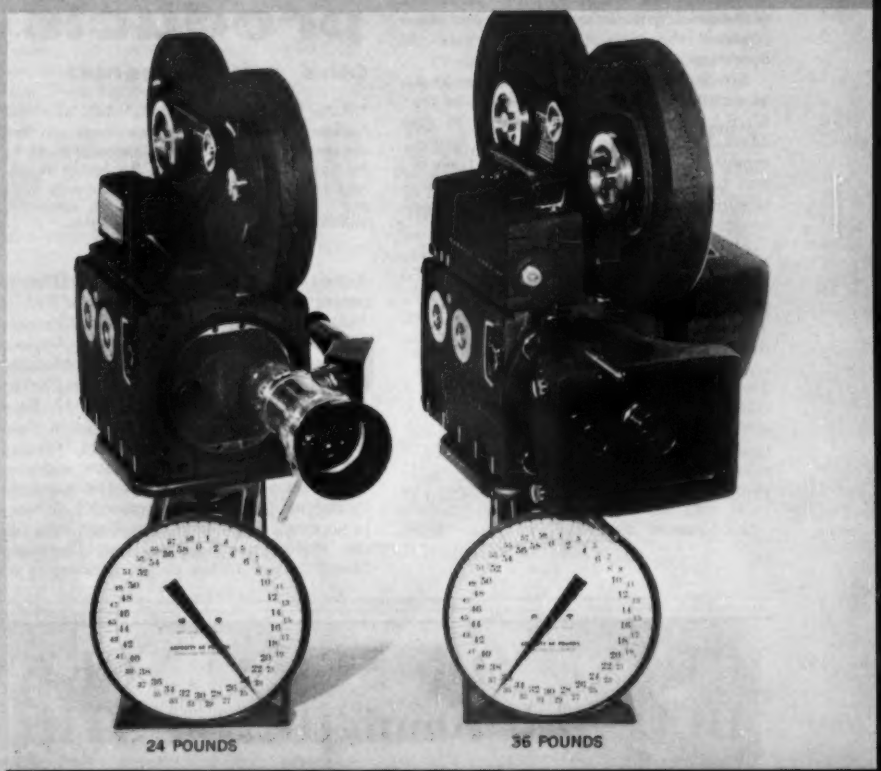

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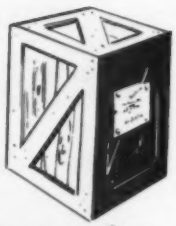
**AURICON...THE PROFESSIONAL CAMERA** • *STANDARD OF THE 16MM SOUND INDUSTRY SINCE 1931*

**The San Francisco Section** met on June 14 at Ampex Corp. Plant in Redwood City with an attendance of 49. Guest speakers were Cyril Teed of Marconi Corp. of London; Charles Swisher and Charles Anderson, both of Ampex Corp. The meeting was devoted to discussions of the Marconi Mark IV Camera and new developments in video-tape recording.

Mr. Teed described the various features of the Marconi Mark IV in his discussion of the new 4½-in. image orthicon and emphasized the high stability and ease of operation of the camera.

Mr. Swisher, representing Ampex Corp. as distributor of Marconi products in the U. S., pointed out other features of the Mark IV including plug-in circuit board, remote iris controls and the new type of lens turret change mechanism. A demonstration of the camera with its associated equipment followed these discussions.

During the second part of the meeting, Mr. Anderson dealt with the newer developments in video-tape recording. He explained and demonstrated Inter-Sync. The use of this new development allows the playback unit to be locked to the station sync making supers and laps possible. The second part of Mr. Anderson's discussion was devoted to an explanation and exhibition of the new miniature Videotape* recorder.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24. (*TM, Ampex Corp.)



# new products (and developments)

**Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.**

**A pair of Norelco Universal 70/35mm projectors** (originally the Philips/Todd-AO) have been installed in the Hollywood Theater of the Screen Directors Guild. The installation, announced by the Motion Picture Equipment Division of the North American Philips Co., 100 E. 42 St., New York 17, was completed early this year. The two Philips machines occupy the two center ports in the theater and are connected with a sound system installed by Ampex Corp. Two Simplex XL 35mm projectors occupy ports on either side of the Philips machines and an Eastman Model 25 arc 16mm projector occupies a fifth port. The theater has a Raytone 2 : 1, 50 by 28-ft curved screen. Three hundred permanent seats have been installed and additional portable seats bring the seating capacity up to 437.

Earlier, this 70/35 projector made a long-run record in two British theaters, the Dominion Theater in London and the Gaumont in Manchestor, each reporting that the first prints of *South Pacific* topped the 1000-run mark.

The design of the projector is based on an illumination principle developed by Philips of the Netherlands in which the light source is a super-high-pressure mercury-vapor lamp operated by current pulses, thus dispensing with the need for a shutter. The projector itself is of simplified design with all components relating to the film path mounted on the flat front panel of a sheet steel column of rectangular cross section to alleviate difficulty of lining up the film path when installing the projector (*Journal*, p. 61, Jan. 1960). About 100 of the Norelco projectors have been installed in the United States and Canada.

**An experimental model of an electronic rear-projection system** based on a light-modulation process developed by General Electric Co. to give extreme brightness and a wide range of image throw-distances was installed in the Los Angeles Sports Arena for the 1960 Democratic National Convention. Designated the Light Valve Projection System, it was leased by Tele-PrompTer Corp. for use at the Democratic Convention. The screen, which shows greatly magnified images, hangs about 35 feet behind the speakers platform and about 55 feet above it. A G-E closed-circuit camera is mounted behind a transmissive mirror in the rostrum in front of the speaker. The mirror reflects the text of the speech and the camera is concealed from the speaker as well as the delegates. The projection system is self-contained except for power supplies. It is manufactured by General Electric Co. for military use. It is not commercially available.

**A high-sensitivity color TV camera tube** designed especially for colorcasts of night sporting events has been announced by the Radio Corp. of America. Designated the RCA-4401, the orthicon is directly interchangeable with types 5820, 6474 or 7513 in existing cameras. The 4401 tubes have been tested for operation under adverse lighting conditions. Results of the tests indicate that 40 ft-c of incandescent illumination can be used with a lens stop of *f*/5.6.

**Ansco Super Hypan,** a black-and-white film used for such applications as high-speed studies, newsreels, instrumentation, time-lapse, etc., is now available in 16mm size, according to an announcement by Ansco, Binghamton, N.Y. The exposure index is 500 Daylight and 400 Tungsten. It may, however, be exposed at indexes up to 1000 Daylight and 800 Tungsten (or higher), according to the manufacturer's report, which suggests a fine grain developer such as D-76. The film is provided with standard perforations along both edges and with single perforations, Sound B. It is also supplied specially perforated for use


PULSE OR SEQUENCE?
HULCHER 70mm DOES BOTH

The Hulcher 70, Model 102 camera is available for remote or local pulse operation by hand or programmed switch, at rates up to 5 per second and simply by flipping a switch, the camera will operate at 10 f.p.s. sequence with same preset exposure. It can also be immediately switched back to pulse operation. Pulse system is complete, requiring only an external switch. Shutter speeds range from 1/50th to 1/1440th of a second for pulse operation. The same camera still operates at sequence rates from 5 to 20 per second. A wide range of lenses with reflex focusing are available. Camera is available for use with 12, 24 or 115 volts.

*Write for detailed information.*

CHARLES A. HULCHER CO., Inc.
911 "G" Street, Hampton, Va.
Phone: Newport News, CHestnut 5-6190

in high-speed cameras It is announced as capable of being used in telecasting directly from the negative by means of electronic reversal. For direct use in television transmission, processing to a gamma in the range of 0.70 to 0.90 is recommended. For use as a normal motion-picture negative, a gamma of 0.60 to 0.65 is recommended. Prices begin at $4.60 for a 100-ft roll, regular and Sound B, and $5.15 (100-ft roll) perforated for high-speed cameras.

**A modified version of the Auricon Cine Voice II,** a portable, transistorized camera used for newsreel photography, has been announced by Television Specialty Co., 350 W. 31 St., New York 1. The camera has a built-in transistor amplifier, VU meter, monitoring jack, and microphone input and weighs less than 16 lb. The amplifier is described as essentially flat from 100 to 20,000 cycles. Ranging from 100-ft to 400-ft magazine and with or without turrets and viewfinders, prices range from about $1800 to $2300.

**The Rubylite Power-Pac,** a self-contained power supply designed to operate the Auricon Cine Voice camera on 115-v a-c current, has been announced by Photomart, 228 S. Franklin St., Tampa, Fla. It is used in locations where regular current is not available. The unit weighs 6 lb with charger and nickel cadmium battery and is said to run 30 rolls of film without recharging. It is priced at $139.50. Larger models for other Auricon cameras.

**Red-I-Frame Lenscreen** portable daylight rear-projection screens are produced by Polacoat, Inc., Blue Ash, Ohio. The screen frame is assembled from sections of tubular parts to which the elastic screen panel is hooked. The rear-screen membrane is of vinyl-latex plastic permeated with special lens cells. The screen may be tilted forward or back. Available in sizes ranging from 4 by 5-ft to 40 by 80-ft (without border) the screen is priced at $2.50/sq ft.

**Two items, 6½-in. and 8-in. high impact plastic video-tape reels,** have been added to the line of video-tape reels and handling equipment produced by the Hollywood Film Co., 956 N. Seward St., Hollywood 38. Each reel is packed in a corrugated shipping container and 48 units are packed in a master carton. The 6½-in. with container weighs 10 oz, and the 8-in. reel with container weighs 14 oz.

**A new ball-socket tripod,** the Gyrosphere Junior, has been announced by S.O.S. Cinema Supply Corp., 602 W. 52 St., New York 19. By means of a spirit level, the top plate is horizontally adjusted. Both friction and fluid heads are accepted by the Gyrosphere and work independently of it. The ball socket and adapter may be installed on S.O.S. Junior and Professional Junior Tripods. Other features include twin-point shoes and one piece leg locks.

**A portable motion-picture lighting unit,** the Cine-Light 250B, said to provide 30 minutes of shooting time at 250-w output, has been announced by the Synctron Division of Electro Powerpacs, Inc., 5 Hadley St., Cambridge, Mass. Designed for versatility, the unit weighs only 14 lb. A heavy-duty filament is used in the light for accurate color temperature. A separate transistor-controlled battery charger is included. Price, including battery charger and nickel-cadmium batteries, is $350. A catalog listing other lighting equipments is available from the company.

**The RA-1627 Mixer** announced by Westrex Corp., a Division of Litton Industries, 111 Eighth Ave., New York 11, is a compact, table-mounted, completely transistorized re-recording mixer. Designed primarily for use with the Westrex RA-1621 Rerecorder, it is also applicable to other re-recording systems where a nominal input level of −5 dbm and a nominal output level in the range of −20 to +16 dbm are to be accommodated. The design is based on a number of electronic modules for incorporation into custom consoles. A 12-page bulletin of illustrations and specifications is available.

**The Series 1200 Portable Magnetic Recording Systems** has been announced by Westrex Corp., a Division of Litton Industries, 111 Eighth Ave., New York 11. The recorders are designed for economy and portability. All cables, two headsets, and a spare set of glassware are included with each system. Microphones, mixer tripod and a bar-type handle to support the mixer in inclined position on a flat surface, are available if required.

**A professional combination stereophonic/monophonic recorder,** the Model 354, was introduced by Ampex Professional Products Co. at the recent Electronic Distributors Show in Chicago. The unit will record and reproduce two-track stereophonic, two-track monophonic (for full-track use), or half-track monophonic. It is priced at $1775.

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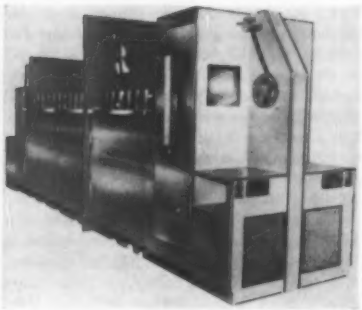
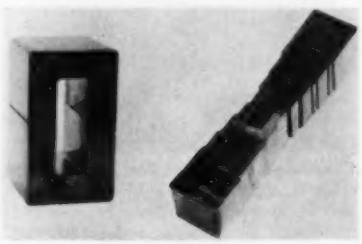


**A series of machines for processing Kodachrome or Moviechrome** (a reversal color film developed by Ansco — ASA rating, 20) has been introduced by Houston Fearless Corp., 11818 West Olympic Blvd., Los Angeles 64. Six models include units for 8/16mm film, 35mm film, and machines that process both simultaneously. The machines are designed with automatic controls to make one-man operation possible. Each unit is self-contained and includes a recirculation and temperature control system. Eight replenishing tanks with pumps and flowrators for each processing solution are provided. Constant-speed drive is from the bottom and the racks are removable. The duplex models have a single set of solution tanks, rinse and wash tanks and dry box with a complete 8/16mm film drive system on one side of the machines and a 35mm drive system on the opposite side. Both 8/16mm motion-picture film and 35mm slide film can be processed at the same time or independently. Processing speeds are from 1500 to 3600 ft/hr for 8/16mm film and from 300 to 1500 ft/hr for 35mm film. The Model 3512 (35mm) and the Model 1625 (16mm) are both priced at $28,450. The Model 525 (duplex) is priced at $37,850.

**The Macbeth QuantaLog Model ET-20 Transmission Attachment,** a product of Macbeth Corp., P.O. Box 950, Newburgh, N.Y., is designed for expeditious connection to the firm's EP-1000 Photometer. When used in combination, the two equipments provide a transmission densitometer said to be capable of reading ASA diffuse transmission densities of 0–4.0 with filters in place, and 0–6-7 log cycles without filters. The transmission attachment has a cantilever type measuring arm to permit accommodation of samples of different thicknesses and an illuminated sample stage allowing for the accurate positioning of samples to be measured. The photometer is equipped with the recommended color printing filters for use on the enlarger easel. Other filters can be easily substituted. The ET-20 Transmission Attachment is priced at $295. The EP-1000 Photometer is priced at $645.

**An automatic processor for rollfilm** used in cineradiography has been announced by Picker X-Ray Corp., a subsidiary of C.I.T. Financial Corp., 25 South Broadway, White Plains, N.Y. The processor is 15 in. wide and 3½ ft long. It will operate on an ordinary electrical outlet (60-cycle a-c). It is said to yield a gamma of 1.7 on cineradiographic film and will process film in lengths up to 100 ft. It can also be used to develop photofluorographic film or any rollfilm up to 70mm. It is priced at $1720.

**Two new microwave diodes,** the IN26BR and IN78DR, featuring low overall noise figures of 10 db and 7.5 db, have been announced by Philco Corp., Lansdale Division, Lansdale, Pa. As with their forward polarity counterparts (the IN26B and IN78D, introduced last year), both reverse crystals feature a metal-to-ceramic hermetic seal within the crystal cartridge designed to withstand operating temperatures of 150 F. Unit prices in the two series range from $9.00 to $72.00 for quantities of 100 or more.



**A new type of electrical transformer,** smaller and lighter than conventional types although designed to have identical operating characteristics, has been introduced by Sylvania Electric Products, Inc., a subsidiary of General Telephone and Electronics Corp., 730 Third Ave., New York 17. The transformer, called the Flexi-core, weighs 18.2 lb and measures 4¼ by 5¼ by 6¼-in.

**The Adler Type UST-10BC Translator** (a rebroadcast transmitter) and the RA-7, a 100-w UHF amplifier, both developed by Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N.Y., are the basic units of the Florida Educational Television Rebroadcast Network. The Network is intended primarily as a low-cost system for the rebroadcasting and relaying of television signals radiated by standard ETV stations operating in Florida. Based on the Heterodyne Repeater principle of TV broadcasting, the RTA-3A heterodyne repeater, designed by the firm for network use, features 10-w output power, no demodulation, use of only 29 tubes, built-in metering and monitoring, crystal-controlled frequency stability, use of 6-mc channel, color or monochrome transmission, and adaptable to standard multiplexing systems.

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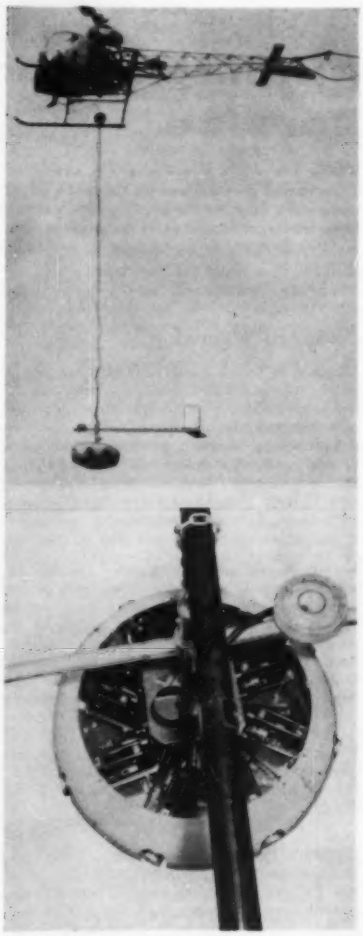
**The Camart Core Dispenser** is a product of Camera Mart, 1845 Broadway, New York 23. The dispenser is attached to a wall for convenient access. It is available in three sizes, 16-, 24- and 36 in., priced at $9.50, $11.50 and $14.50. Also available is a 24-in. dispenser for 50-ft or 100-ft plastic reels. It is priced at $24.00.

**Heavy-duty Car-Top Clamps** to support a camera tripod on top of a car or other moving vehicle have been announced by Camera Mart, Inc., 1845 Broadway, New York 23. The clamps are of bronze weather-proof construction. A set of three is priced at $28.00.



**A camera system composed of eight separate cameras** attached to a towing helicopter has been announced by Par Products Corp., 602 Colorado Ave., Santa Monica, Calif. Known as the Flying Saucer Camera (FSC), the eight cameras, synchronized to operate as one, are mounted on a rotatable circular platform housed in a disc containing eight shooting ports. The bottom of the disc is protected while landing by a pneumatic bag attached to the under structure. To stabilize the camera system in flight, a boom is attached to the disc which has flight-stabilizing fins, flutter indicator and a flight level indicator. The system is attached to the towing helicopter by a 25-ft cable and is controlled by the cameraman. A series of films is planned to be made during an around-the-world trip, starting in Manhattan and covering Paris, Egypt, India, Japan, the Pacific, San Francisco and the Grand Canyon before returning to New York. The films will be shown at Freedomland in the Bronx, late in 1960. They will be shown in a specially constructed theater to carry out the flying saucer motif.

**The M3000 digital tape transport,** announced by Midwestern Instruments, Inc., P.O. Box 7186, Tulsa, Okla., features higher effective transfer rates and higher usable tape speeds. It is designed for easy modification to meet particular system requirements. The unit has been engineered to avoid the use of parts, components or techniques that might be susceptible to excessive wear or require complicated servicing. Since the equipment is intended for use in widely differing systems special attention has been given to modular arrangements of components.

**An extremely fast (30 frames/sec) pulse camera,** Model 370, has been announced by Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif. Designed to be used with the firm's Slip-Sync system in industrial studies such as destructive resonances in vibration tests, it is also used for conventional pulse camera data recording and for time-lapse work. The camera uses standard 16mm 100-ft roll film. Auxiliary Slip-Sync equipment permits slow-motion photography of cyclic events. In vibration tests the stroboscopic illumination and the camera are both synchronized to the vibration. Price of the camera with 1 in. $f/1.9$ lens is $1850.

**A photographic recorder** designed particularly for telescope tracking installations has been announced by Benson-Lehner Corp., 1860 Franklin St., Santa Monica, Calif. Designated the HS-70A photographic recorder, it is capable of a speed up to 80 frames/sec. It has a film capacity of 1000 ft in interchangeable magazines. The shutter is of the focal plane rotating disc type and the opening is adjustable from 2° to 90° with manual adjustment.

**A new technique, which combines magnetic and optical effects to permit direct visual observation of transformations between superconductive and normal states,** has been developed at General Electric Research Laboratory, Schenectady, N.Y. The technique is based on the fact that a sufficiently strong magnetic field can change a material from superconductive to normal, but while the material remains superconductive it is a magnetic insulator. The specimen to be observed is usually prepared in the form of a flat disc. On top of the sample is placed a plate of a special cerium phosphate glass about 1/100 in. thick. When magnetized this glass has the property of rotating the plane of polarized light. Monochromatic polarized light is beamed on the glass, and the reflected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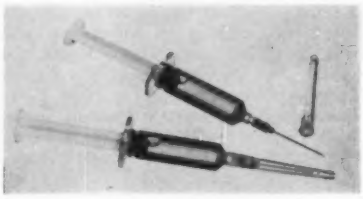
light is viewed through a polarizing filter which can be rotated to any desired angle. At certain magnetic field strengths the specimen is in the intermediate state, that is, portions of it are normal and other portions are superconductive. The superconductive areas shield the portions of the glass plate directly above them from the magnetic field, so these parts of the glass are not magnetized. The portions of the glass above the normal areas are not shielded and are magnetized. The parts of the glass that are magnetized rotate the plane of polarized light they reflect, while the parts that are shielded do not. By adjusting the polarizing filter through which the reflected light is observed, the magnetized portions of the glass can be made to appear dark and the unmagnetized portions light, or vice versa. Since this pattern of light and dark corresponds exactly to the pattern of superconducting and normal metal in the sample, changes in the state of the sample can be observed and photographed directly.

**An electronic enlarger** used in both color and black-and-white still photography is a product of LogEtronics, Inc., Alexandria, Va. Announcement was made by Colortronics, 911 G St. N.W., Washington 1, D.C., which recently installed the machine. The enlarger utilizes a moving-spot light source similar to the light in a television tube. Scanning the photographic negative to be used in making an enlarged print, it varies in brightness automatically as it moves across the picture.



**A new type of handy packaging for instrument lubricants** has been announced by National Camera Repair School (NCRS), Box 174, Englewood, Colo. The lubricants are contained in disposable syringes to serve the double purpose of keeping the oil clean and at the same time instantly available for pin-point application. Two types of lubricants are available. All-Temp Lube for sliding levers and similar friction points is priced at 60 cents, and Moly Lube for motion-picture camera springs is priced at 70 cents.

**A new method of packaging two-part epoxy adhesives** has been developed by Plastic Associates, 2900 S. Coast Blvd., Laguna Beach, Calif. Small plastic containers called PA Packettes hold premetered quantities of both adhesive and catalyst. The exact amount of catalyst required to activate the adhesive is included in each container when it is filled. The contents are mixed immediately before using, the adhesive applied to the parts to be bonded and the empty container thrown away, thereby relieving mixing and measuring and clean-up problems. A number of bonding agents are offered in the new package including PA-815, designed for bonding glass or ceramic surfaces; PA-746, a special formulation for treated Teflon, and PA-708, a metal-to-metal adhesive. The latter is priced at $1.50 for a box of 10 Packettes, mixing sticks and protective gloves.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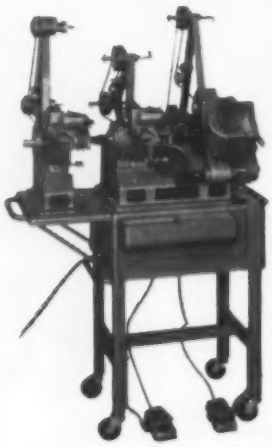

*Model UD-20-S shown with cabinet extension and extra sound head.

Cabinet extension bracket with mixing controls and coupling attachments complete.
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16mm or 35mm** Optical and magnetic sound head.
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3. Strong, easy to install from furnished instructions.

*Specify existing model Moviola for which extension is required.
**Specify 16 mm or 35 mm when ordering separate sound head.

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## Positions Wanted

**Assistant to Top Executive.** Willing relocate or travel. Administrator-Consultant-Technician all phases photo industry USA and abroad. Production, sales and sales promotion; along with extensive processing, recording and editing experience. Planned, erected, installed and operated studios and labs in many locations. SMPTE member some 25 years. 10 Brookside Drive, Apt 4D Greenwich, Conn. TOwnsend 9–5090.

**Sound Recording Technician.** Cuban, 30, married. Over 12 yrs experience all types mixing for radio, television, records and film; recording on tape, disk and 16mm optical; multitrack re-recording and sound reading for animation. Specialist in music recording and tape editing. Employed as sound production consultant with large advertising agency. Desire permanent position in Latin America or U.S. to handle either technical job or sound production for radio and TV advertising. Fluent in Spanish, English and German. Complete résumé on request. Pedro E. Misner, Montero Sanchez 21, Vedado, Habana, Cuba.

**Director, Producer, Cameraman, Instructor.** Practical and admn. experience in educational and TV film production, also in 16mm motion-picture laboratory supervision and still photography. Masters Degree in Cinema, Univ. So. Calif. Present contract as Film Unit Director for the National Education Television Mathematics Film Study, Univ. of Illinois, ends Sept. 1, 1960. Age 32, married. For résumé write or call: Byrl L. Sims, 1102-A West Main St., Urbana, Ill.; EMpire 7-6611, Ext. 3837.

**Motion Picture Editor and Cameraman.** Presently with N.E.T.R.C. Math Study Film Project at Univ. of Ill. as Head Editor and Head Cameraman. Formerly with N.O.T.S. China Lake as Cameraman and Editor. B.A. and part M.A. from Univ. of Southern Calif. Dept. of Cinema. Also experienced in motion picture laboratory, still work, and other aspects of film production. Interested in a challenging position with potential. Write or telephone for resume or Form 57; day: EMpire 7-6611, ext. 3837; night: EMpire 5-1038; Stanley Follis, 1311 South Cottage Grove, Urbana, Ill.

**Sound Engineer.** Young Indian desires position as sound engineer in a well-established organization. Brilliant academic career. Graduate in Science. Three years Diploma in Sound Engineering. Well versed in equipment maintenance and procedures and motion-picture laboratory practice. Enterprising and hard-working. Prepared to work as 'Apprentice Trainee', if desired. Member of Audio Engineering and Associate Member of SMPTE. Write: M. K. Srivatsa, 17, Rangarao Road, Shankarapura, Bangalore-4, India.

**Trainee.** Israeli student, 31, motion pictures graduate UCLA '60, speaks 7 languages, with rich background in public relations, needs opportunity for practical training in any phase of cinematography or television production. Will travel. New York or Los Angeles areas preferred. Write P.O. Box 24533, Los Angeles 24.

**Writer-Director.** Experienced in production of technical, educational, training and promotional films. Background includes editing, camera and sound. Experienced in military electronics field. Desires position with unit actively engaged in production. Married, BA degree, willing to relocate. Write: Film Director, 4813 "B" St., Philadelphia 20, Pa.

**Producer-Director.** Winner of national awards. Currently employed, but desirous of obtaining challenging position where hard work, enthusiasm and ability are needed. Experienced in all phases of production. Capable of handling crews and supervising production from script to screen. Background in industrial and educational films. College cinema grad. Write: Producer, 3100 Kelton Ave., Los Angeles 34, Calif.

**Motion-Picture Engineer.** B.Sc. Elect. Eng., 15 yrs experience all engineering phases motion-picture production and services, mainly sound recording. Administrative and management experience as well as complete layout, design, installation, operation and maintenance of two sound recording studios. Fellow SMPTE, member of Sound Committee. Age 38, married, fully bi-lingual, French and English, would relocate. R. J. Beaudry, 9 Badger Dr., Toronto 18, Ont., Canada.

**Writer-Producer.** Young man, 27, with college background in documentary film production. Have written and produced business and training films with top Chicago studio and educational films for largest studio in the field. Desire position with film producer anywhere in U.S.A. or abroad. Write B.K., 820 W. 79th St., Chicago 20, Ill.

**Cameraman.** Presently employed shooting special photographic effects, miniatures, inserts, mattes, rear projection, and stop-motion animation for a special-effects company. Have experience with black-and-white, Ektachrome and Eastman Color, also CinemaScope, on feature films, TV commercials, TV series and industrials. Employed 2 years on TV series as dimensional animator, later as production manager on same cartoon series. Also experienced with editing and A & B roll cutting. USC degree. Age 28, single. Desire position with educational, commercial or industrial film company. Resume on request. R. Rodine, 5636 Laurel Canyon Blvd., North Hollywood, Calif. POplar 1-0728.

**Cinematographer.** Motion-picture or visual aids specialist. 1960 grad. Univ. Calif., B.A. in motion pictures. U.S. citizen, born and raised in Germany. Two languages fluently. One yr professional experience as director photog. with TV advertising agency in 16mm motion-picture and TV slide-film production. Serious student cinema since age 12. Also experienced sound recording and as projectionist, 16 & 35-mm. Interested in career job, technical and creative end theatrical or industrial film production. Age 31. Prefer U.S. but free to travel. Member SMPTE and IATSE. Write: Dieter W. Kaisenberg, P.O. Box 1142, Hollywood 28.

**Electro-Mechanical-Optical Engineer.** Graduate, 10 yrs experience in development, research and design of precision instruments. Presently employed as supervisory engineer. Optical patent currently being processed. Attending evening graduate physics courses. Desire challenging work in optical instrumentation and/or design; will consider related work. Resume and references upon request. Harry Silver, 65-61 Parsons Blvd., Flushing 65, N.Y. OL 8-0133.

## Positions Available

**Chief Engineer.** To take charge of product development and diversification program for well known manufacturer of tape recorders and audio equipment. Company located in Chicago requires man with strong engineering background and knowledge of audio circuitry. Experience with magnetic recording devices and systems will be helpful but not necessary. Ability to operate at top executive level is essential. Five figure salary and other incentives. Send data on background and experience confidentially to: John M. Watkins, Suite 1604, 28 East Jackson Blvd., Chicago 4, Ill.

**Electronic Engineers.** Circuits and Systems, Development and Design in fields of Broadcast and Closed-Circuit TV, both Commercial and Military. Transistorized Circuit experience necessary. Fastest-growing company in field. Many benefits. Profit-sharing in ownership available. Foto-Video (Electronics, Inc.,) 36 Commerce Rd., Cedar Grove, N. J. CEnter 9–6100.

**Motion - Picture Production Salesmen.** Excellent opportunity for men in all corners of the world to affiliate themselves with a new motion - picture production unit. Salesmen should have contacts in industry, public relations and advertising fields to sell motion-picture and film-strip productions. Write giving full details of area you can cover. Allegro Film Productions, 723 Seventh Ave., New York 19.

**Sales Manager/Sound Studio.** To develop and carry out sales-marketing program to sell sound recording service to film producers, advertising agencies and broadcasters. Technical background in recording techniques plus understanding and know-how as to sound problems of users required. Special emphasis on video tape services. Send resume and salary requirements in full confidence to W. P. Fiske, 1 East Putman Ave., Greenwich, Conn.

**Film Inspectors, Film Librarian.** Temporary or permanent. Write or call Peerless Film Processing Corp., 165 W. 46 St., N. Y. 36 Tel. PLaza 7-3630. Att: Kern Moyse.

**Sales Engineers.** For electronic equipment, closed-circuit TV, etc., in districts of Boston and Chicago. Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J. CEnter 9-6100.

**Motion-Picture Timer.** Experienced technician for color filmstrip laboratory. Excellent opportunity for man with aptitude to join growing organization. Duties involve negative handling, color timing, control of tests, answer prints and production. Some knowledge of camera work and animation helpful. Reply confidentially to: M.G., 68-46 Groton St., Forest Hills 75, N.Y.


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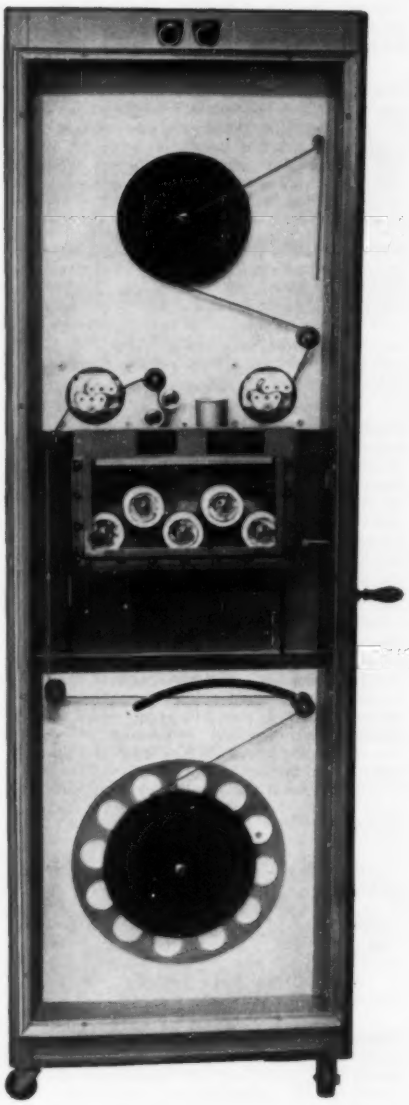

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### Meeting Calendar

SPIE, 5th Annual Technical Symposium, Aug. 1–4, Ambassador Hotel, Los Angeles.

AIEE, Pacific General Meeting, Aug. 8–12, 1960, San Diego, Calif.

National Audio-Visual Convention, Aug. 6–9, 1960, Hotel Morrison, Chicago.

International Astronautical Federation Congress, Aug. 15–20, Stockholm, Sweden.

Western Electronic Show and Convention, Aug. 23–26, Los Angeles.

Electron Microscope Society of America, Annual Meeting, Aug. 29–31, Marquette Univ., Milwaukee, Mich.

European Conference on Electron Microscopy, Aug. 29–Sept. 3, 1960, Delft, Netherlands.

Standards Engineers Society, Sept., Pittsburgh, Pa.

Illuminating Engineering Society, National Technical Conference, Sept. 11–16, Penn Sheraton Hotel, Pittsburgh, Pa.

International Scientific Film Association, 14th Congress, Sept. 16–24, Prague, Czechoslovakia.

Deutsche Gesellschaft für Photographie, 1st International Congress on Medical Photography and Cinematography, Sept. 27–30, Düsseldorf, Germany.

International Center of Photography Congress Sept. 27 – Oct. 1, Florence, Italy.

Armour Research Foundation & IRE, 6th Conference on Radio-Interference Reduction and Electronic Compatibility, Oct. 4–6, Museum of Science and Industry, Chicago.

ASCE, National Convention, Oct. 9–13, Boston, Mass.

Electrochemical Society, Meeting, Oct. 9–13, Shamrock Hotel, Houston, Texas.

AIEE Fall General Meeting, Oct. 9–14, Chicago.

NEC National Electronics Conference, Oct. 10–12, 1960, Hotel Sherman, Chicago.

Optical Society of America, Annual Meeting, Oct. 13–15, Somerset Hotel, Boston, Mass.

Fifth International High-Speed Congress and Equipment Exhibit, sponsored by the SMPTE, Oct. 16–22, 1960, Sheraton-Park Hotel, Washington, D.C.

Symposium on Space Navigation, Oct. 19–21, 1960, Columbus, Ohio.

Acoustical Society of America, Fall Meeting, Oct. 20–22, San Francisco.

ISA, AIEE, IRE, Sponsors, 13th Annual Conference on Electrical Techniques in Medicine and Biology, Oct. 31–Nov. 2, Sheraton-Park Hotel, Washington, D. C.

AIEE, API, ONR, IRE, Metallurgical Society, Sixth Annual Conference on Magnetism and Magnetic Materials, Nov. 14–17, New Yorker Hotel, New York.

ASME, Annual Meeting, Nov. 27–Dec. 2, Statler Hilton Hotel, New York.

American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, New York.

ISA, Winter Instrument-Automation Conference and Exhibit, Jan. 16–19, 1961, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.

IRE International Convention, Mar. 20–23, 1961, New York Coliseum, New York

ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, 1961, Shamrock-Hilton Hotel, Houston, Texas.

**89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.**

**90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.**

**91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.**

**92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.**

**SMPTE Officers and Committees:** The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

# sustaining members

of the Society of Motion Picture and Television Engineers

**The objectives of the Society are:**

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of high professional standing among its members;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

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The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Byron Roudabush, c/o Byron Motion Pictures, Inc., 1226 Wisconsin Ave., N.W., Washington 7, D.C.